APPLIED HYDRAULICS

THE MAGAZINE OF FLUID POWER TRANSMISSION

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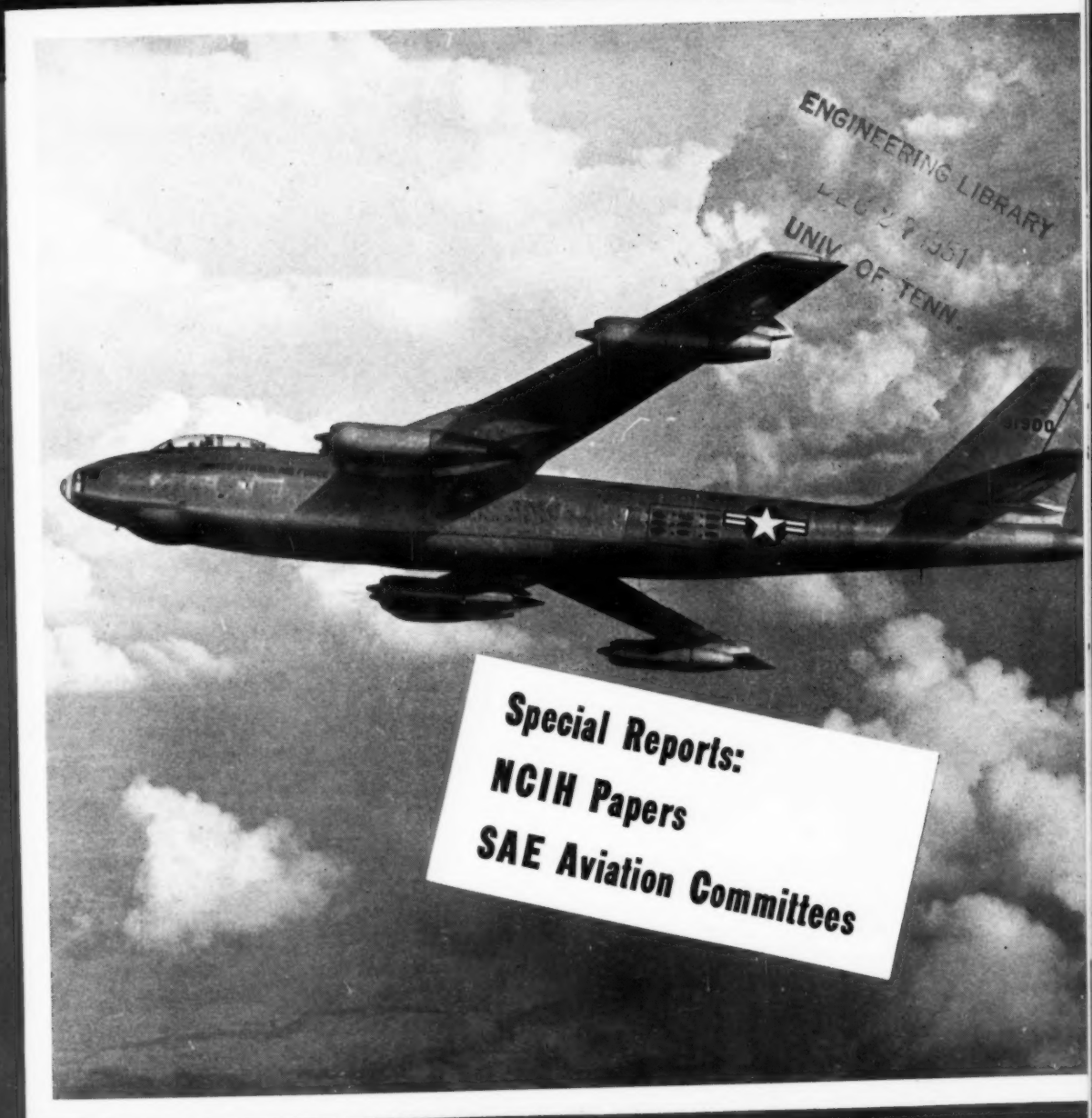

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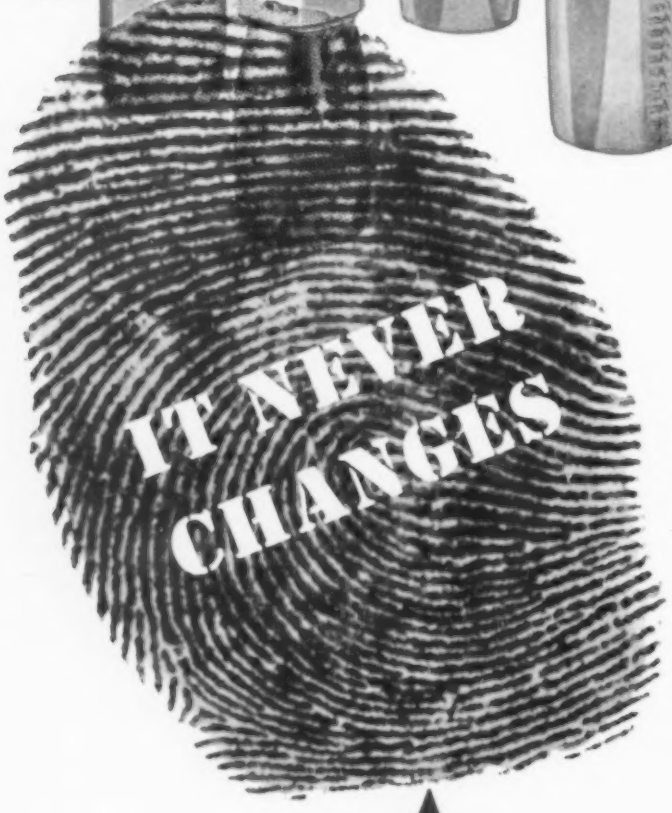
DECEMBER, 1951

Also

- PNEUMATIC CIRCUITS
- PNEUMATIC CONTROLS
- ELECTRICAL and ELECTRONIC CONTROLS

IN THIS ISSUE

HIGH PRESSURE TESTING
TEMPERATURE REGULATION IN HYDRAULIC SYSTEMS
PRECISION TIMING OF LATHE TOOLING
STANDARD CIRCUITS FOR SPECIAL JOBS
DESIGN WITH CENTRAL ACCUMULATOR SYSTEMS
HYDRAULIC CYLINDERS



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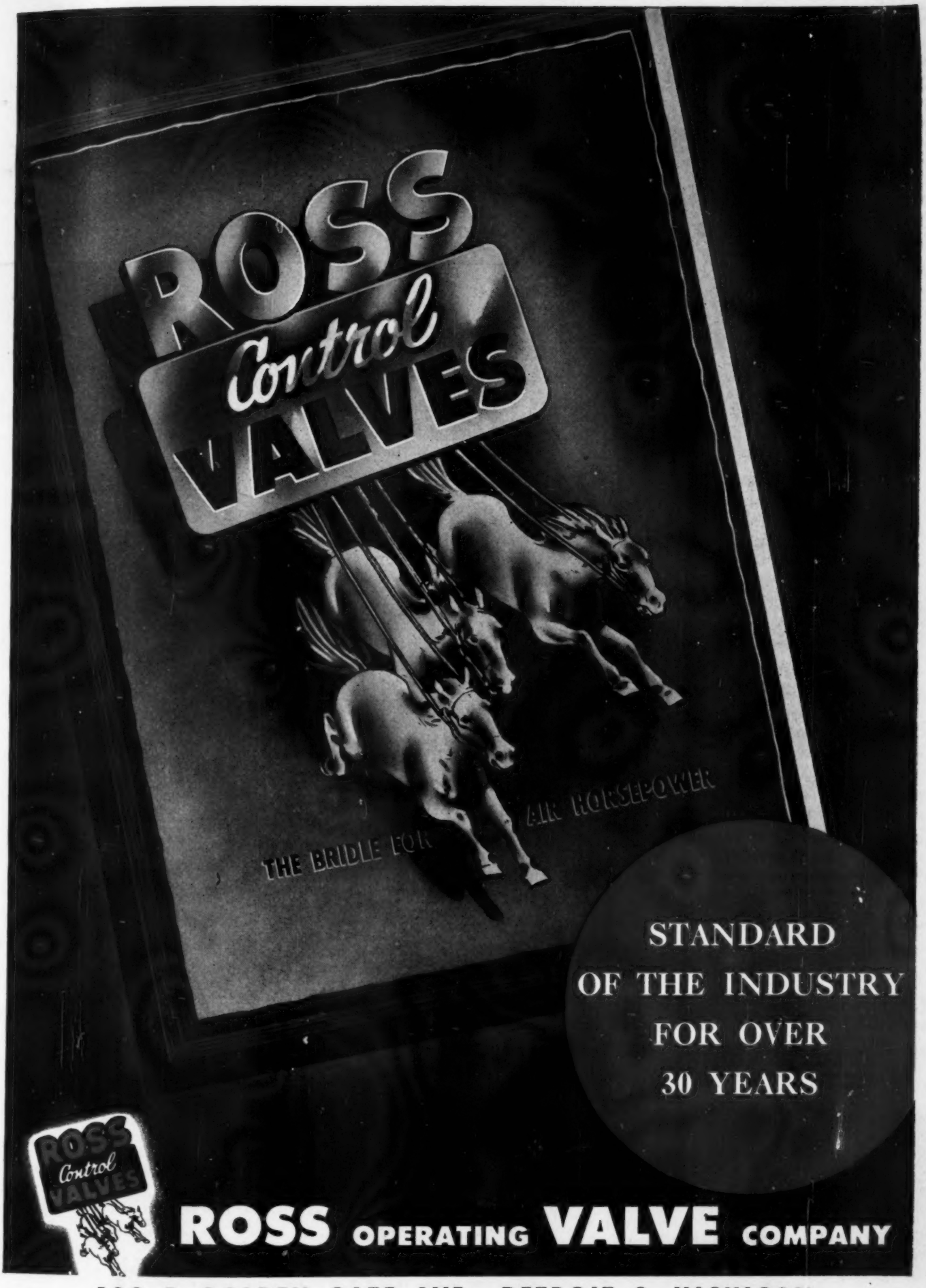

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DECEMBER 1951
Vol. 4, No. 12

APPLIED HYDRAULICS

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LETTERS to the Editor

We have been reading articles in the technical press on the rather extraordinary characteristics of titanium for small high pressure tubing. Is this tubing available? If it is, we would like to have full information on bending and flaring it.

J. T.

As far as we can ascertain, only very limited quantities of titanium tubing have been made. Considerable testing is in process in Service laboratories and in laboratories of airplane manufacturers and the mills that are producing it. At a recent SAE committee meeting, reported in the Aviation Section this issue, one of the leading airplane manufacturers distributed a report on their test program to date. To all intents and purposes titanium tubing is not available. We do not believe that fabricating procedures are far enough along for any of the producers to issue specific instructions for potential users.

* * *

Would you please send to the attention of the writer a few copies of the article "Rotary Hydraulic Motors" which appeared in the October 1951 issue of your magazine.

W. B. H.

We are pleased to send three sets of tear sheets of the article "Rotary Hydraulic Motors", an installment in our series "A Beginner's Course in Basic Hydraulics".

* * *

We are very much interested in obtaining any available literature on "Mechanics of Pneumatic Controls". Are reprints of your past articles available in booklet form?

W. C.

We have been issuing both title and author indexes to the articles in APPLIED HYDRAULICS each year. Companies in this field that have published bulletins and technical data that will assist you includes: Bailey Meter Co.; Brown Instrument Div. Minneapolis-Honeywell Regulator Co.; Foxboro Company; Mason-Neilan Regulator Co.; and C. J. Tagliabue Corp., Div. of Weston Electric Instrument

Concluded on page 18

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LITERATURE AND SERVICES OFFERED IN THIS MONTH'S ADS

AVIATION AIR COMPRESSOR Walter Kidde & Company, Inc. offers data on their compressors designed to operate to altitudes of 35,000 feet.

Circle 27 on Reader Service Card

LEATHER PACKINGS Want to know more about Rhoads Tannate to meet your exact packing requirements? Write to J. E. Rhoads & Sons for details.

Circle 61 on Reader Service Card

QUIET PUMP operation means smooth continuous flow. Brown & Sharpe's Pump Catalog describes their line using helical gears operating on roller bearings to assure quiet continuous flow.

Circle 12 on Reader Service Card

OIL FILTRATION Technical bulletins available from U. S. Hoffman Machinery Corporation, describe methods and equipment for oil conditioning.

Circle 52 on Reader Service Card

"HOW TO SOLVE PUMPING PROBLEMS" is the title of a handy booklet prepared by Geo. D. Roper Corporation. You'll find charts, tables and typical problems in selecting pumps all worked out.

Circle 73 on Reader Service Card

THE GEROTOR principle of gear pump operation for pressures to 1200 psi is discussed in an available catalog. Complete specs are given.

Circle 14 on Reader Service Card

HIGH PRESSURE PUMPING APPLICATIONS The new Hydramite pump for constant delivery to 5000 psi and the Hele-Shaw pump for variable delivery to 3000 psi are described in bulletins offered by American Engineering Company.

Circle 5 on Reader Service Card

Concluded on page 11

Concluded from page 8

AIR FILTER LUBRICATORS For data on how to purify, lubricate and regulate compressed air, write to Air Conversion Research Corp. for literature describing their units.

Circle 71 on Reader Service Card

CARTRIDGE TYPE packing gland is featured in the design of Petch cylinders for air and hydraulic service. Engineering data on these cylinders with a self contained packing gland is offered.

Circle 45 on Reader Service Card

HAVE YOU CONSIDERED the unloading Gear-type gear pump for conventional variable volume pump applications? Specifications and performance charts are available on this new Pesco design.

Circle 28 on Reader Service Card

THE BEST WAY to know what size packings are readily available is to have a list of mold sizes carried in stock by the manufacturer. Along with complete packing data, Periflex, Inc. supplies you with this information.

Circle 30 on Reader Service Card

LEAKPROOF CHECK VALVE Engineering data will be supplied detailing James-Pond-Clark's Circle Seal check valves for pressures to 3000 psi.

Circle 37 on Reader Service Card

REUSABLE HOSE ENDS You can get complete details on hose assemblies and reusable hose ends in Catalog H-1451-A offered by The Weatherhead Company.

Circle 10 on Reader Service Card

HYDRAULIC STANDARDS Do you have your copy of the J.I.C. Hydraulic Standards? You can get them by asking the Miller Motor Company who has prepared them in a handy folder.

Circle 16 on Reader Service Card

ELECTRICALLY CONTROLLED valves for handling air or oil in systems to 250 psi are detailed in Bulletin 501 issued by Skinner Electric Valve Div., The Skinner Chuck Company.

Circle 64 on Reader Service Card

CONSIDER HOSE assemblies for circuit flexibility and convenience. Resistoflex Corporation has prepared specification sheets for their line of assemblies.

Circle 43 on Reader Service Card

METALLIC PACKING for increasing the life of hydraulic cylinders are described in literature offered by Hydraulic Accessories Co.

Circle 47 on Reader Service Card

DARCOVA PUMPCUPS Designed for reciprocating pumps and air and oil cylinders, these packings are described in Bulletins 4401 and 4502. Darling Valve and Manufacturing Co. has prepared these bulletins to show actual performance data.

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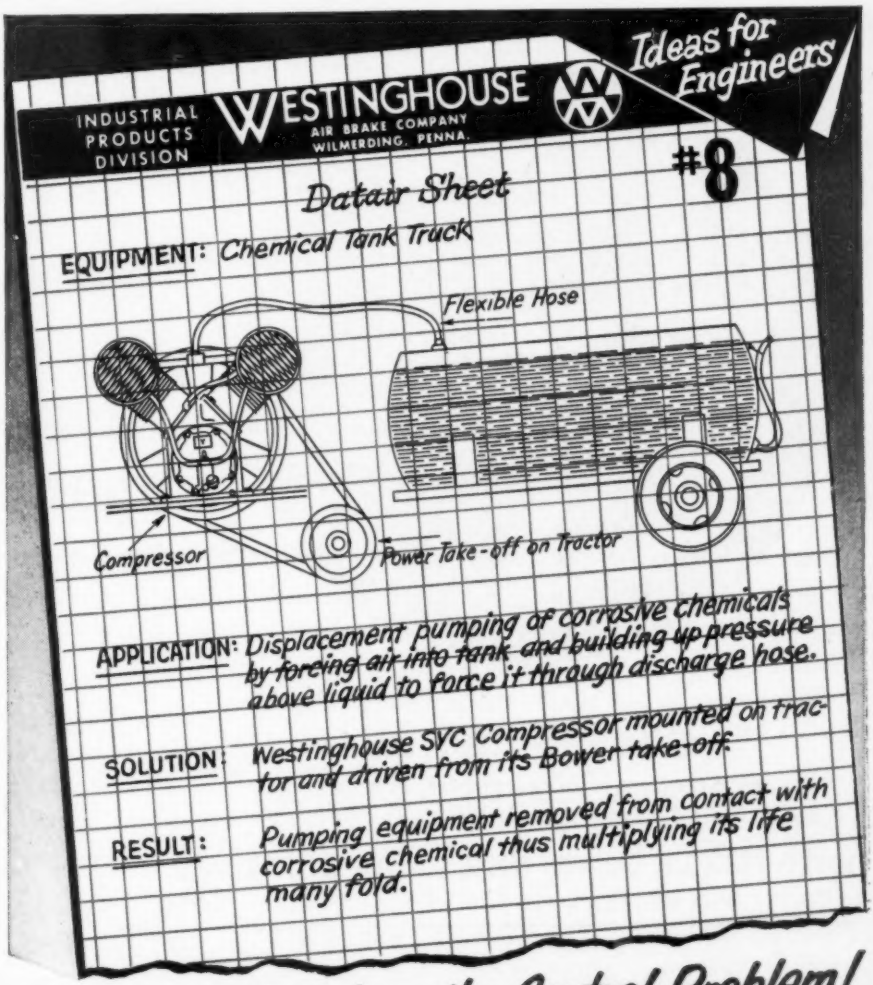
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WESTINGHOUSE
AIR BRAKE COMPANY
WILMERDING, PENNA.
Ideas for Engineers
#8
Datair Sheet
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Flexible Hose
Compressor
Power Take-off on Tractor
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SOLUTION: Westinghouse SVC Compressor mounted on tractor and driven from its Bower take-off.
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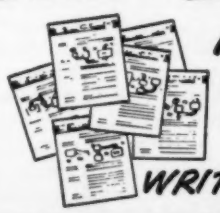

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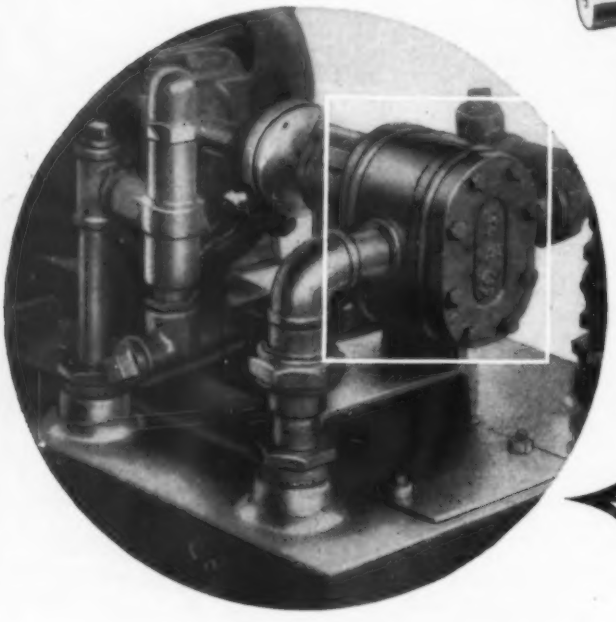
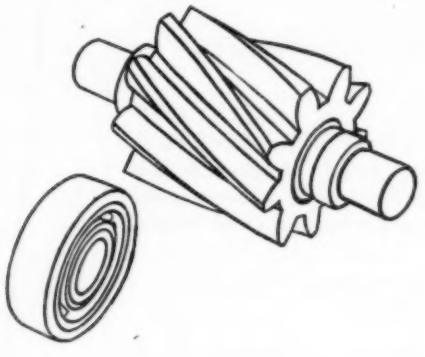


for hydraulically-operated machines

Nos. 53 and 55
ROTARY GEARED PUMPS
with Helical Gears and Roller Bearings



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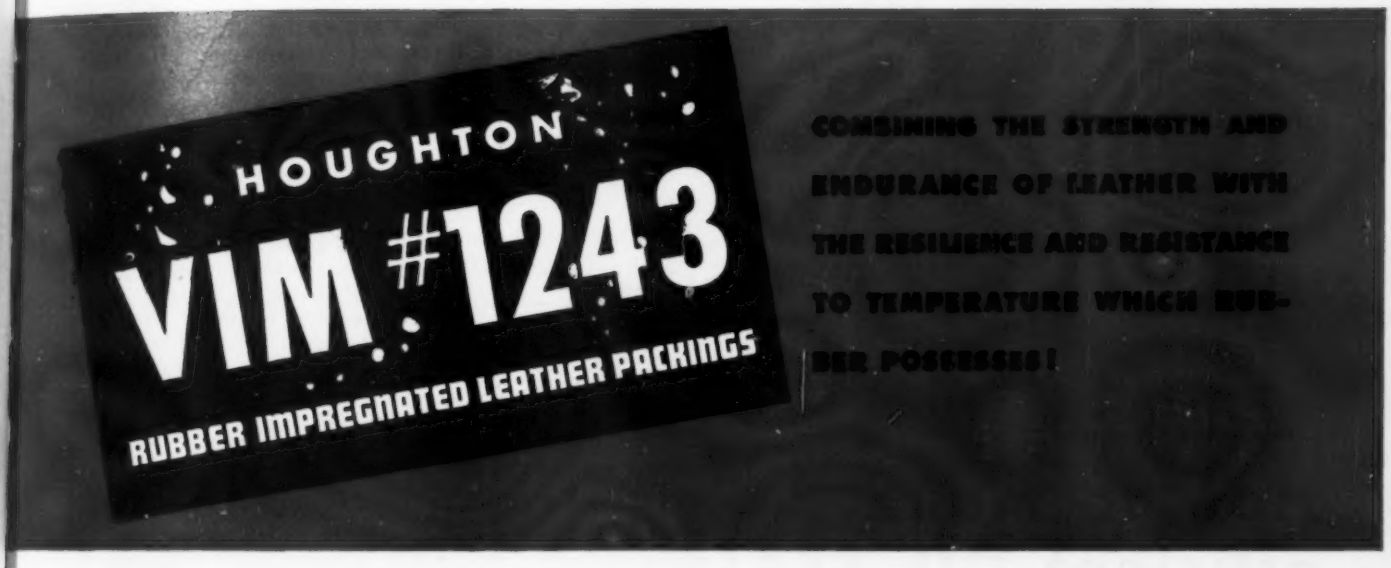
Vim IMPREGNATED LEATHER PACKINGS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COMBINING THE STRENGTH AND ENDURANCE OF LEATHER WITH THE RESILIENCE AND RESISTANCE TO TEMPERATURE WHICH RUBBER POSSESSES!

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How to make efficient OIL SEALS with fewer metal parts

Oil Seals must be designed for specific jobs.

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For Grakone (Synthetic) Bonded OIL SEALS

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Concluded from page 4

Co. A complete list of manufacturers in this field are listed in the APPLIED HYDRAULICS Directory (January 1951 issue).

* * *

Our organization is growing rapidly with the increased use of industrial hydraulics and we have acquired many engineers who are new to the hydraulics field. In order to train these men we have resorted to an internal instruction course in basic hydraulics and we have had much occasion to refer to your publication. Unfortunately, we did not catalog all the Basic Hydraulics installments. Have these been reprinted?

W. S

We have made no provision to reprint the "Beginner's Course in Basic Hydraulics". However, we believe that two training courses in successful operation may be of interest. A training course in practical applied hydraulics is being conducted in the Caterpillar Tractor Co. at Peoria, Ill. by Paul G. Griebel. A very successful airline base shop training program is in operation at Holman Air Base, St. Paul, Minn., conducted by Northwest Airlines, Inc. under the supervision of Ray Van Cott. The latter training program is described in an article "Mockup Saves Time in Maintenance Training" in the October issue of APPLIED HYDRAULICS.

* * *

I am interested in obtaining back issues of APPLIED HYDRAULICS to include January of this year.

L. F. P.

Because of the demand most back issues are out of print. However, we are sending copies of issues which are still available. We suggest that you index the articles you are especially interested in. For your information the January 1952 Directory Issue will contain both a title and author index of the articles run through 1951 in APPLIED HYDRAULICS.

* * *

I am unable to ascertain the name of the manufacturer of "Monopak", a hydraulic piston packing. Could I prevail upon your good offices to request the manufacturer in question to send me engineering data on his product?

G. E. F. Jr.

The manufacturer is Hydraulic Accessories Co., 439 E. Fort St., Detroit 26, Mich. Data requested has been forwarded.

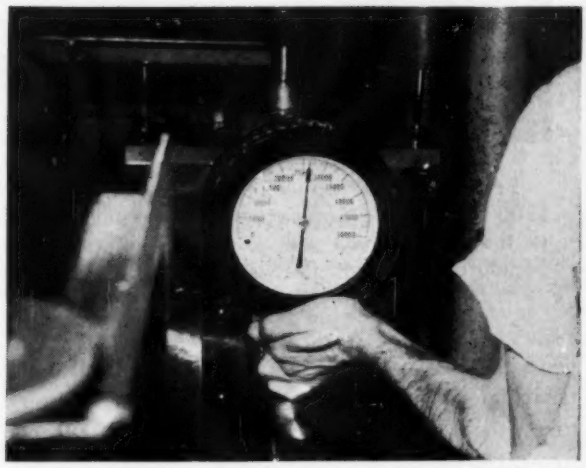
HIGH PRESSURE TESTING:

Rocket bodies handled with safe precise control

By Harry Horner and Paul Tracht

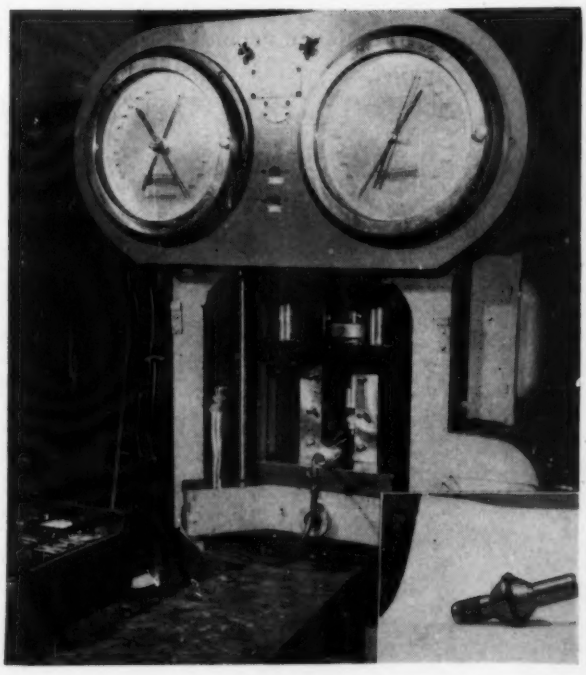
Because of the growing number of test schedules whch call for 100 percent inspecton of parts, production men are being called upon to revamp laboratory test setups to do top performance work at high production rates. The changeover to shop tooling from laboratory equipment, which is usually built for precision without regard to speed, requires considerable ingenuity aided by close cooperation between the laboratory technicians and production men.

An important part of the armament program is the production of rocket bodies being carried out at the Evans Products Company in Plymouth, Michigan. Hydrostatic testing of these bodies is extremely critical. Each body is important, there can be no imperfect bodies passed on to assembly.



Proof pressure of 25,000 psi is checked with a master gage.

Laboratory setup for rupture test of rocket body. Front safety panel is removed. A strain gage pressure cell accurately measures burst pressure on the strain indicator in the foreground. High pressure sealing is accomplished by use of the sealing plug seen in the inset.

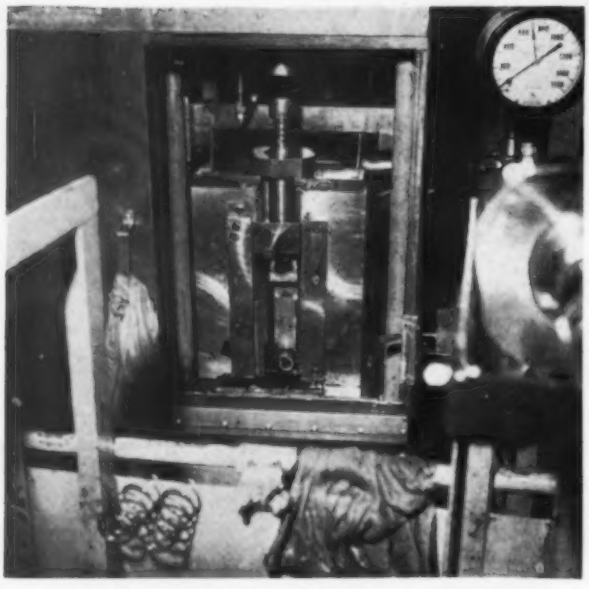


CONTROLLED pressure, rate of production, and safety to personnel were our topmost considerations in the development of hydrostatic test equipment for rocket bodies. Each body must be subjected to a pressure of 25,000 psi for a period of two seconds. The equipment design requires first, a method of generating this high pressure with commercial equipment; second, efficient, safe automatic cycling; third, a rugged fixture making possible quick load and unload.

To meet projected production and considering load, test and unload time along with operator fatigue and downtime for scheduled pressure checks, two machines were built.

Fixture and equipment design were worked out by maintenance engineering and industrial engineering. Laboratory test work on the rocket bodies is being continued to maintain data on destructive

Harry Horner, plant engineer; **Paul Tracht**, laboratory supervisor, Evans Products Company, Plymouth, Mich.



Production setup with rocket body in the fixture. 1500 psi pressure gage measures hydraulic pressure at the pump which will go to 700 psi to develop 25,000 psi proof test pressure in the body.

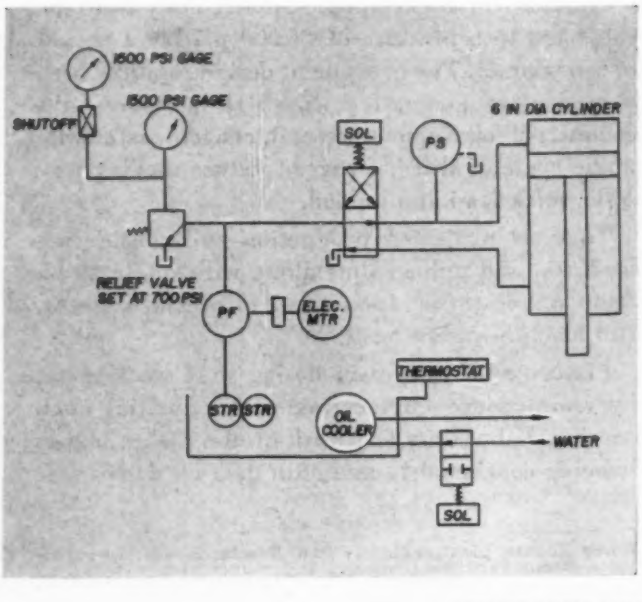
At a drain table in front of the machine, the bodies are prepared for testing, and tested bodies have the sealing plug and plunger removed. The oil stream coming from the pipe fills each body.

tests. This data is important in the control of heat treating and material specs of the bodies. The rupture pressure is considerably in excess of the proof pressure.

The laboratory test setup shows the rugged precision finished fixture in which the body is loaded. Before loading the body, the simple sealing plug seen in the photo inset is dropped into the tapered bottom of the body. The use of an "O" ring has provided excellent sealing for maximum burst pressures. Actually, the seal becomes tighter as pressure builds up above the sealing plug. With the plug in place, the body is filled with oil and the top cap holding the pressure plunger is screwed into the body.

Concluded on page 54

Pressure generated by a vane pump is controlled by the setting of the relief valve. Note that the setting has been wired and locked. The tubing leading from the relief valve goes to the pressure gages. One gage reads during each cycle, the second is cut in as an added check at regular intervals. The pressure switch actuates a timer to hold test pressure on the six inch cylinder for the two second interval. During this two seconds the pump is unloading at peak 700 psi pressure through the relief valve. To economically dissipate the generated heat, automatic thermostat control of the oil cooler is included.



By Don Morrell

TEMPERATURE REGULATION in Hydraulic Systems

WHILE the majority of hydraulic systems used in machine tools and other industrial equipment do not require temperature regulation, there are many applications where temperature regulation is desirable and often necessary. This statement will be qualified by a description of the characteristics of oils, particularly petroleum base fluids, under various operating conditions. An attempt will be made to show that this statement is true in some cases even for efficiently designed hydraulic systems.

Figure 1 is a standard ASTM Viscosity-Temperature Chart. The solid diagonal line represents a hydraulic oil used in many types of machine tools and a wide variety of industrial production machines. The oil has a viscosity of approximately 150 seconds at 100 F, Saybolt Universal (SSU) and a viscosity index (VI) of 85. The oil is a non-additive type, the relatively high VI indicating that it is relatively stable, made from good crudes and a good oil for cold starts. The operating range, indicated by circled points, well within the operating temperature specs of the JIC Hydraulic Standards, does however, show a 400 percent difference in fluid resistance to flow, with a 350 SSU at 70 F and a VI of 85 SSU at 130 F. The probable leakage factor varies inversely with the same ratio 4:1.

The merits of additive versus non-additive hydraulic oils will not be discussed. However, it is pertinent to point out that the use of high VI oils are of no practical value in minimizing feed and cycle variations due to temperature changes. For example, a 150 VI oil which has a viscosity of approximately 150 SSU at 100 F, would have a viscosity of 300 SSU at 70 F and a viscosity of 92 SSU at 130 F. This would represent a leakage factor of 3.25:1 as compared with the 85 VI oil leakage factor 4:1.

It is not unusual on some machine tools with fine feed included in the cycle to displace less fluid for the feed than what is lost through internal leakage. It is easy to see, therefore, that an operating temperature range of 70-130 F, which increases the leakage factor four times, or three and one-quarter times, could not be tolerated.

The triangular symbols on Figure 1 indicate the limits that most authorities believe to be within the most efficient operating temperature range for hydraulic systems. Note that at 110 F, the viscosity is 120 SSU and that at 120 F the viscosity is 100 SSU. This represents a 20 percent difference in fluid resistance to flow with the probable leakage varying inversely with the same ratio 1.2:1 viscosity change.

Check Points for Temperature Regulation

1. How much variation in machine feed can the tooling tolerate and still maintain high quality parts and long tool life?
2. How much variation in total machine cycle time can be tolerated without affecting overall production schedules or the operation of the tie-in equipment such as automation?
3. What about the existing hydraulic equipment in the plant that may have any one or more of the following bad conditions which temperature regulation may economically correct?
   - (a) An original inefficiently designed hydraulic system
   - (b) A hydraulic system that has been beefed-up to handle higher production schedules
   - (c) An efficiently designed system with the work load cycle too much out of proportion to the idle phase to permit proper dissipation of heat.

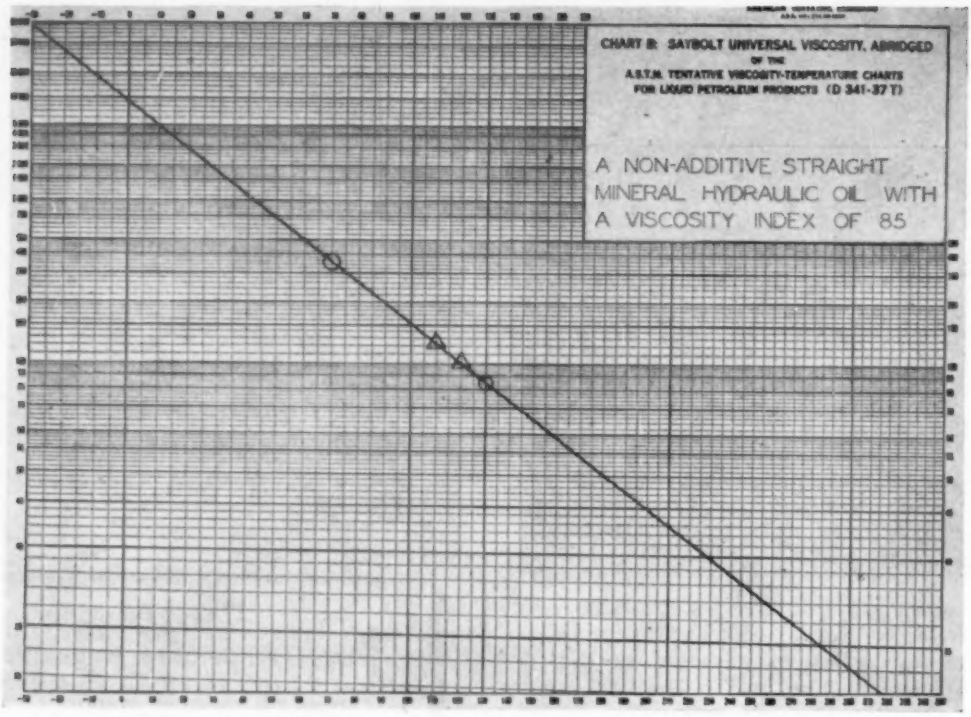


CHART B: SAYBOLT UNIVERSAL VISCOSITY, ABRIDGED
OF THE
A.S.T.M. TENTATIVE VISCOSITY-TEMPERATURE CHARTS
FOR LIQUID PETROLEUM PRODUCTS (D 341-37 T)
A NON-ADDITIVE STRAIGHT
MINERAL HYDRAULIC OIL WITH
A VISCOSITY INDEX OF 85

Fig. 1. The operating range of 70-130 F (circles on chart) are within operating temperature spec of JIC Hydraulic Standards but the VI difference, 350 SSU and 85 SSU respectively, means a probable leakage factor varying inversely with the same ratio 4:1. The triangular symbols indicate a much smaller VI change, 120 SSU at 110 F and 100 SSU at 120 F, giving a probable leakage factor of 1.2:1 viscosity change. This graphically represents the reduction in leakage rates obtainable easily and economically with heat exchangers and automatic temperature regulating devices.

Why do most authorities consider this operating range the most efficient? First, there is little change in viscosity. For example, the same temperature spread is indicated in the viscosity differential between 70 and 90 F. Second, the higher the operating temperature the greater the leakage and the more the oil tends to oxidize, forming harmful sludges and varnishes. It has been established that, with all other factors constant, rates of chemical reactions (oxidation) more than

Unit	Operating Pressure	Temp. F	Leakage in Cu/in/Min
Piston Pump	5000 psi	70	9
		85	18
		122	27.5
Vane Pump	1000 psi	70	255
		100	295
		130	450
Flow Control Valve (drain port leakage)	1000 psi	70	4
		100	21
		130	30
			Output Locked Setting Cu/in/Min.
Flow Control Valve (Output Variation varies cycle time, applied as meter-in, meter-out or bleed-off)	1000 psi	80	313.7
		120	323.4
		160	339.3

Fig. 2. Leakage characteristics in hydraulic units in relation to operating temperatures.

doubles for every 18 F increase in temperature above 140 F.

Fortunately, the desirable operating temperature range of 110-120 F can be obtained inexpensively by the use of commercially available temperature regulating devices and heat exchangers.

Figure 2 gives actual test leakage characteristics in several hydraulic units operated at temperatures from 70 to 130 F. The flow control valve leakage figures are drain port leakages.

Metered flow variation due to oil temperature change is also given in Figure 2. The output variations on a flow control can either increase or decrease cycle time, depending on whether it is applied as meter-in, meter-out or bleed-off.

It will be noted that though all leakages vary considerably, representing conditions that would be undesirable on many hydraulic systems without temperature regulations, conditions do not exactly correlate with the viscosity curve shown in Figure 1. Besides differences in laminar and turbulent flow rates, the apparent reason is localized heat as the oil passes through a hydraulic unit, e. g., a spool is completely heated by the oil stream and the body is only partially heated because much heat is lost through surface radiation. This results in unpredictable rates of metal expansion between spool and body bore. The writer feels that this is the cause of binding of valves on many overheated hydraulic systems.

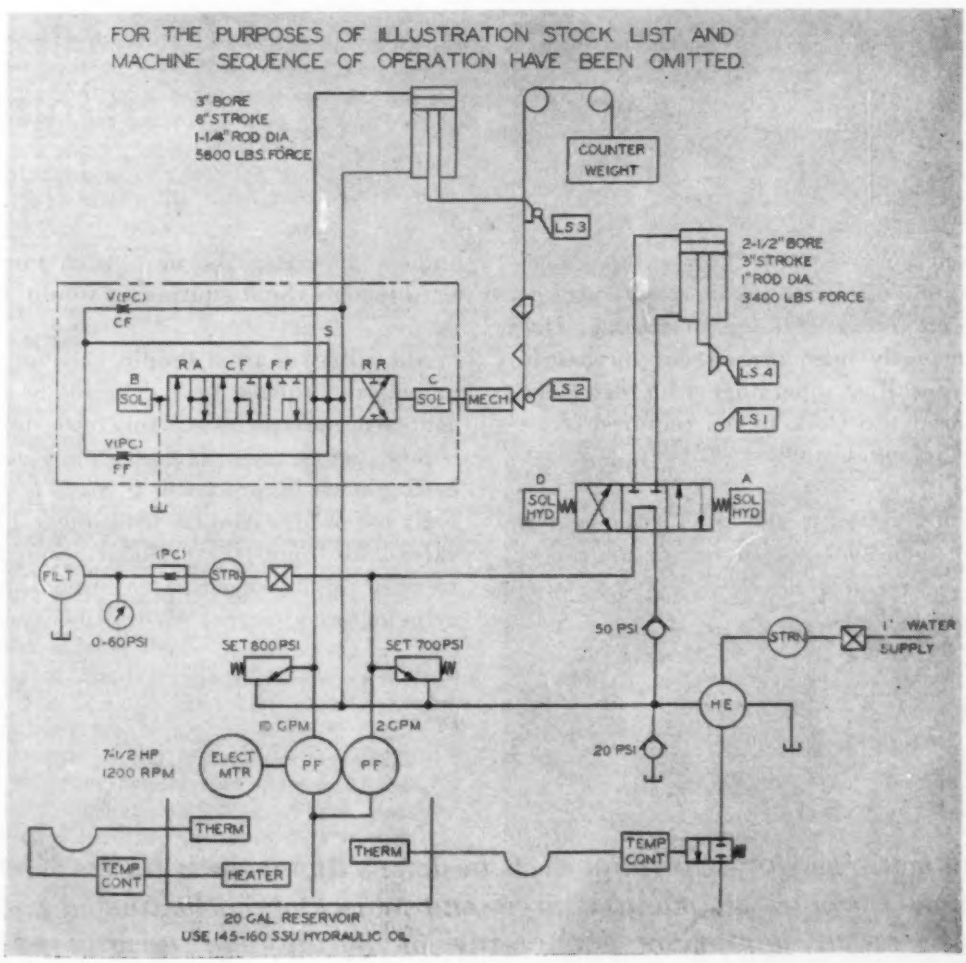
The JIC Hydraulic Standards cover temperature regulation directly or indirectly in 12 paragraphs. Only the most directly pertinent paragraph is quoted. Paragraph H5.10 states *"When heat exchangers are used, they shall be equipped with suitable automatic thermal controls"*.

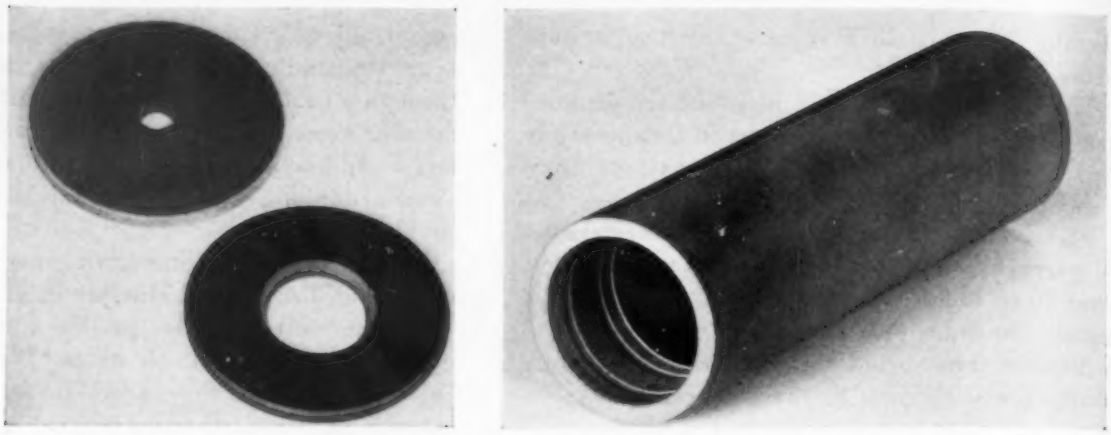
The writer feels that heat exchangers with suitable automatic thermal controls are an economic solution to many feed and cycle problems. However, it is also the writer's opinion that the use of heat exchangers with only manual controls is not economical and does not accomplish the purpose intended on production machines.

Figure 3 is a circuit diagram of a temperature regulated hydraulic system such as might be used

Continued on page 72

Fig. 3. JIC symbol diagram of a hydraulic circuit incorporating a temperature regulated hydraulic system for a production boring machine.





Two end caps and a sleeve form the textile bobbin. The sleeve must be bored and internal grooves cut in both ends. End caps must be radiused on the outside edge of a 3½ in dia, and a bevel is cut on the edge of a 1¼ dia center hole, and then the hole is cut out. After assembly a slot for a drive key is cut.

Precision Timing of Lathe Tooling

with limit switch controlled air and hydraulic cylinders

By J. L. Straub

HIGH production schedules for a laminated plastic bobbin used on textile machines required the development of automatic tooling. The parts had previously been turned out on bench type lathes by skilled operators who carefully turned and bored the work to the required close tolerances. Production was slow; skilled manpower was being tied up.

The apparent solution to this production tie-up was to provide some means of powering the cross-slide and carriage of our bench lathes. No new hard-to-get capital equipment would then be needed.

Air cylinders are a simple, economical means of moving the cutting tools. The major problem was control of movement—cutting feeds must be smooth—positioning must be accurate—and automatic cycling must be precise.

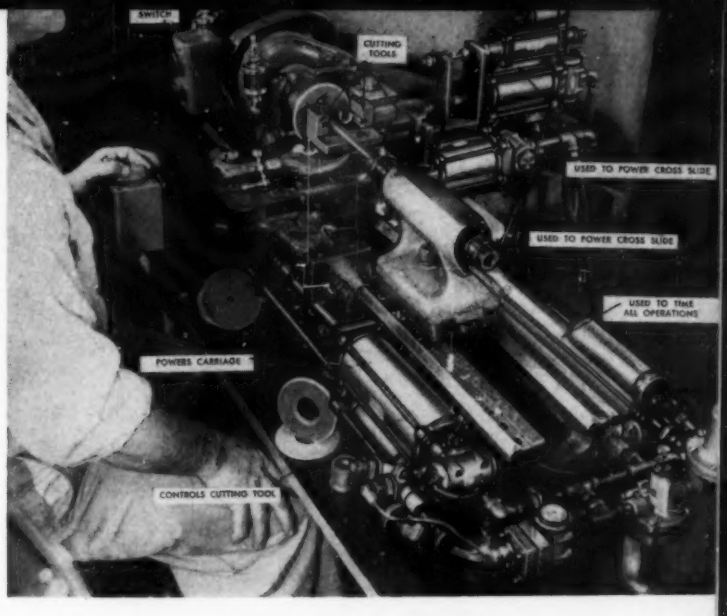
By use of air cylinders with integral Electroaire* valves, we found the cylinder response to be extremely reliable cycle after cycle. Controlling air cylinder travel with a Hydro-Check* provides the

Concluded on page 54

J. L. Straub, Automatic Machine Room Superintendent. Synthane Corporation. Oaks. Pa.

Many automatic machine operations can be done without costly timers. Here's how the Synthane Corporation, manufacturers and fabricators of laminated plastics for industry, uses air equipment for timing of boring and turning operations.

End cap tooling—Two separate cross slide feeds are used to complete the end caps. The upper cylinder and Hydro-Check controls the radius tools, and the lower cylinder moves the parting tool. Rapid advance of the carriage is accomplished by an air cylinder and a Hydro-Check comes into action as the bevelling tool is fed into the work. A separate air cylinder tripping micro switches controls the timing.

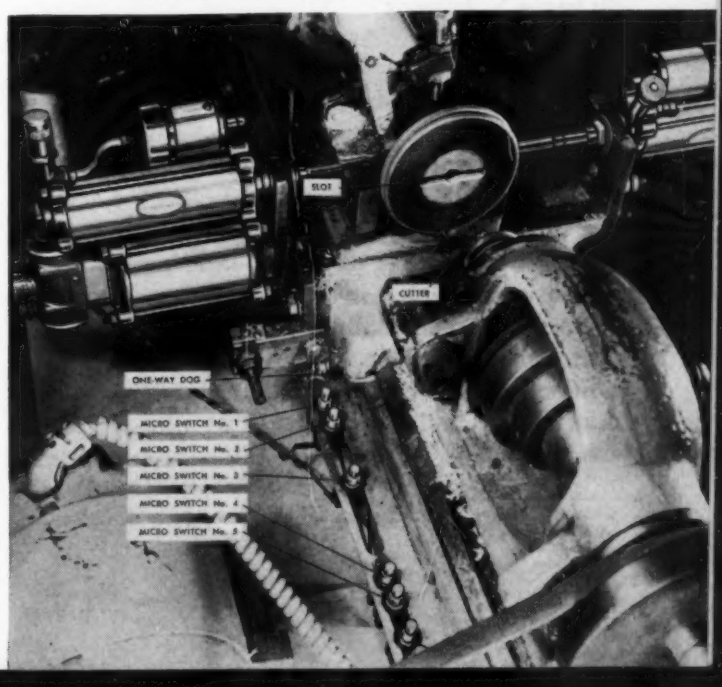


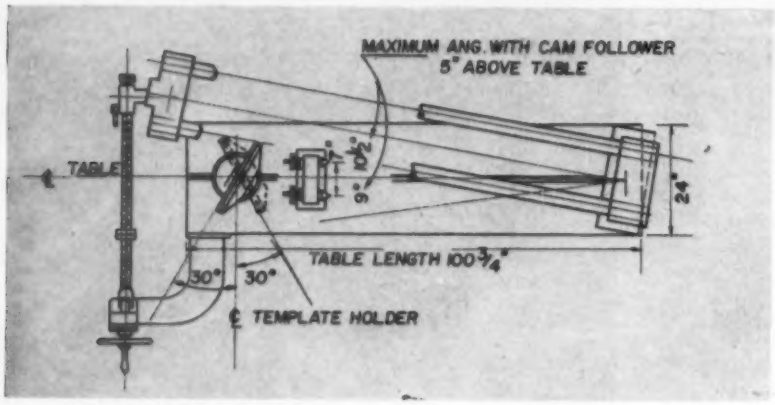
Machining the sleeve—An air cylinder and Hydro-Check are used to time the cycle by tripping microswitches as the piston moves forward. Micro switches actuate the solenoid operated Electroaire valves on the carriage and cross slide cylinders.

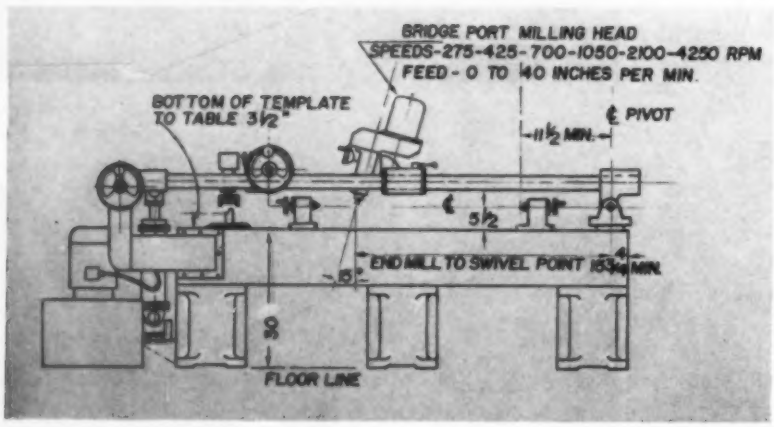
The boring operation is first performed as the carriage feeds the tool into the work. With depth held by a positive stop, a second micro switch is tripped causing the cross slide to advance and cut the grooves. Three more micro switches provide for reversal of slide, carriage and timing cylinder to complete the cycle.

All photographs courtesy The Bellows Co., Akron, Ohio

Cutting the drive key slot—End milling slots for drive keys is pictured from the head stock of the lathe. The part is clamped by hand and the timing cylinder travel is started when the operator pushes the start button. Tripping of the micro switches, as the timing piston advances, first actuates the cross slide cylinder and almost simultaneously energizes the advance side of the air cylinder powering the carriage. The carriage brings the part to the end mill at the center hole of the bobbin. Continued advance of the cross slide feeds the part into the cutter under close control of the Hydro-Check, milling one half of the slot. Micro switch 3 reverses the cross slide to mill the other half of the slot. Micro switch 4 returns the carriage and 5 returns the timing cylinder. The unit is ready for the next cycle.







Here are the plan and elevation views of the milling machine designed for contoured tapered shapes. A standard vertical milling head is mounted on the two rods which run the length of the table. A flow control valve controls the speed of a rotary fluid motor which provides longitudinal cutting feed to move the entire milling head the length of the two rods.

In-feed or cross-feed is manually controlled by the handwheel. The entire milling head is swivelled about the pivot to give the tapered shape. Contour is determined by the template. The clevis mounted, tracer controlled cylinder, raises and lowers the cutting head.

Standard Circuits for Special Jobs

reduce design time and cut machine cost

By Gale S. Humes

PRESENT day designs of products for both commercial and armament use require careful consideration of machining methods for precision contouring. The special machine built by the Navy Air Development Center for contouring airfoil is a typical example of the production problems involved in machining irregular forms.

Most shop men and industrial hydraulic engineers consider duplicating systems to be a valuable production tool. However, many of these men feel that understanding the design of tracer circuits should be left for the servomechanism engineer. The simplicity of the standard tracer circuit used on the Navy mill should dispel any such feelings.

Admittedly the duplicating requirements here are simple—only up and down motion is required and the tracer acts only at the ends of the cut—no speed problems are introduced. Many duplicating jobs have similar requirements which can be met with this standard circuit.

As seen in the circuit, the 1.5 gpm vane pump is powered by a small ¾ horsepower electric motor. Even this small power input is not fully used because the load on the 5 in dia cylinder is only several hundred pounds. The maximum pressure setting established by the relief valve is 150 psi. This low

Gale S. Humes is chief engineer, Turchan Follower Machine Co., Detroit, Mich.

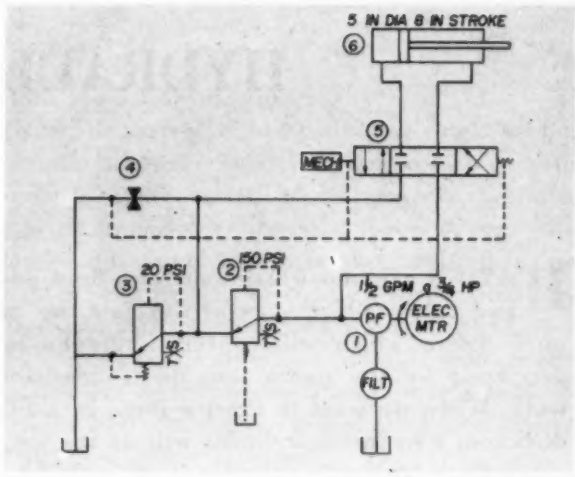
In the November APPLIED HYDRAULICS, Abraham Schwartz of the Naval Air Development Center in Johnsville, Pa., described the machining problems encountered in finishing airfoil contours. Although the work is highly specialized and a complete new milling machine was built, standard hydraulic circuits supplied the power feed and precision contour tracing. On these pages, Gale Humes, Turchan Machine Company's chief engineer presents design data on the circuit used in the Navy machine—a circuit which is readily applied to many machine tools for high production contour machining.

operating pressure minimizes leakage problems and makes it convenient to pipe the circuit with low pressure hose.

Another advantage of low pressure is low heat generation to give more accurate reproduction and longer life to the machine. On the Navy machine, the tracer valve only operates at the ends of the cut which means that while cutting the valve is in neutral with pressure port blocked and the pump unloading to tank through the relief valve. Temperature does not rise appreciably nor is power loss great at the low volume, low pressure setting.

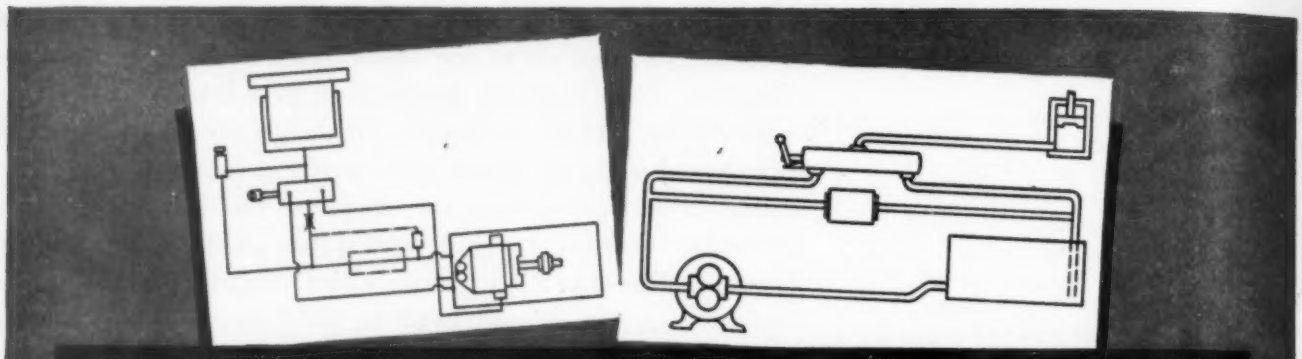
Valve 3, in the circuit, is set to give a back pressure of 20 psi which acts to stabilize the action of the tracer and produce a suction across orifice 4. Exhaust oil rushing through the venturi-like orifice creates a suction to pull excess oil from the tracer valve. To minimize friction on the tracer valve no seals are used. Any leakage past the spool is pulled off to tank by the simple vacuum system.

The tracer valve is the heart of the system. Basically it is a three position, 4-way valve which is positioned mechanically by the camming action of the tracer tip on the template. The valve is spring offset to the downward feeding position and assumes this position whenever the tracer tip is not in contact with the template. When the hydraulic power is on then, the power cylinder will pull the tracer down to make contact with the template. As contact is established the tracer tip will push the valve spool upward gradually cutting off the flow of oil to the cylinder until at center position movement ceases. The valve will hold the cylinder motionless in this position while a cut is taken the length of the airfoil. At the end of the cut the cross handwheel is indexed the required amount, the tracer tip is deflected by the rising template, the valve spool is raised to reverse feeding position and the cylinder feeds upward. As the cylinder raises the tracer away from the template the valve spool returns to center position accurately positioning the head for the next cut.



Standard tracer circuit as used on the Navy's special milling machine. The circuit has a minimum of components and uses a standard motor, pump and pressure controls. The carefully designed tracer valve is essentially a 3 position, 4-way directional valve which meters flow to the power cylinder in response to movement of the tracer tip.

Due to the design of the valve this action is very rapid, smooth, and accurate. Basic design of this servo control valve requires consideration of the axial force necessary to operate the piston. This force has three principal components: inertial force, frictional force, and third the force created by the fluid flow through the metering orifices (Ports) of the valve. Proper design and manufacture minimize these forces to produce a valve capable of accurately positioning a machine tool. In this particular case the cut made only a few ten thousandths of an inch deviation from the master template profile.



A Beginner's Course in Basic Hydraulics

Chapter XI

HYDRAULIC CYLINDERS

HAVING a pump which generates fluid power and valves which control the flow, we need some device which will convert hydraulic force developed by the pump into useful mechanical work. When we want to exert a force in a linear direction, a hydraulic cylinder will do the job.

Briefly, a hydraulic cylinder is an enclosed cylindrically bored housing in which a piston is reciprocated by the action of oil pressure. The piston rod extends out of the cylinder housing offering a means of attaching the load which is to be moved by the piston action.

The principle of force multiplication is one of the major advantages of oil power and one of the prime reasons for selecting fluid power for brute force jobs. It has long been known, that fluid under low pressure applied to a large area will support and move a large load. This relationship:

$$\text{Developed Force} = \text{Oil Pressure} \times \text{Working Piston Area or } F = PA$$

is one of the two prime considerations in selecting the correct size.

While all oil systems require that the cylinder be able to exert a certain force, many systems also require that the piston move at a given rate of speed.

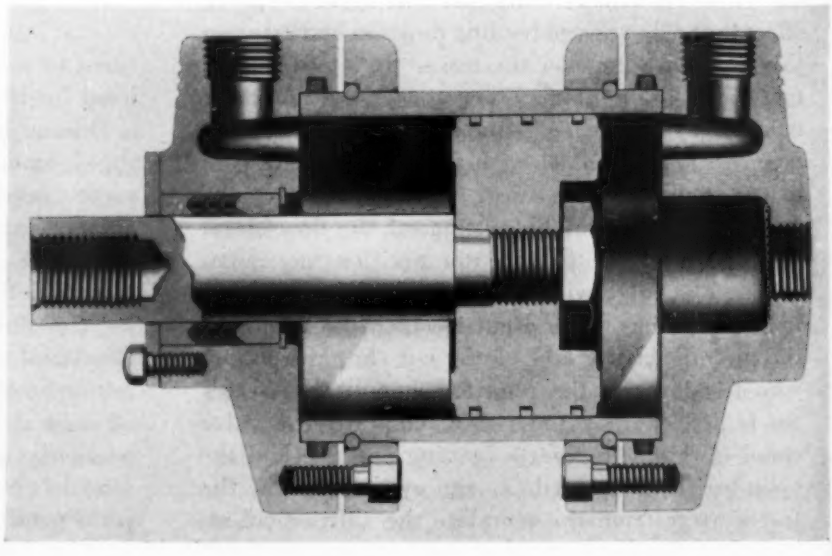


Fig. 1. Cross section of a high pressure double acting hydraulic cylinder. Metallic piston rings seal the piston head. Chevron packing is used at the rod end and an "O" ring seals the end cap joints.
Courtesy Rivett Lathe & Grinder, Inc.

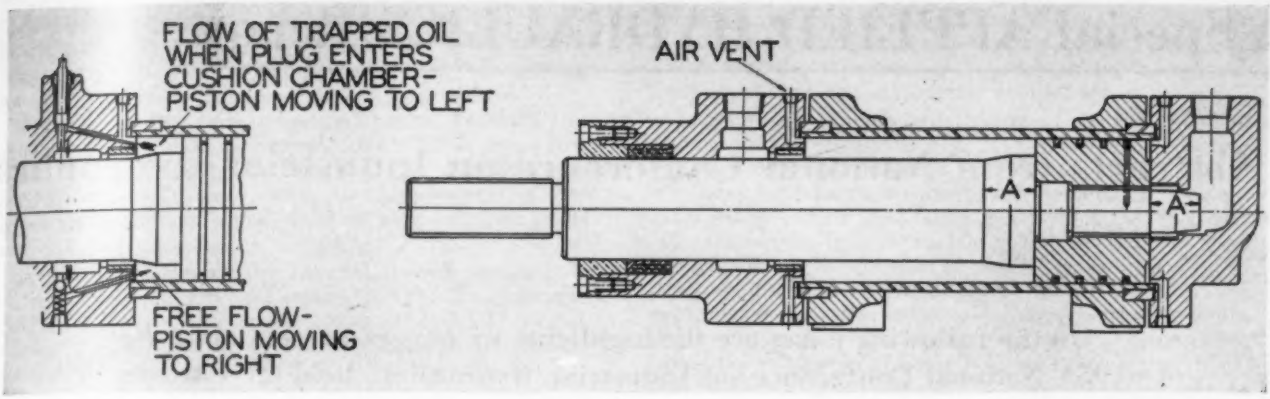


Fig. 2. Cushions in the cylinder ends reduce the shock of stopping the piston travel against the end of the cylinder. Oil forced into a small orifice creates a back pressure to cushion the shock.
Courtesy Hannifin Corporation

This gives us the second relationship:

$$\text{Rate of speed} = \frac{\text{Pump Delivery}}{\text{Working Area of Piston}}$$

$$\text{or } R = \frac{Q}{A}$$

Using these two simple equations the proper selection of pump and cylinder can be made to do a given job. There are many commercial cylinders on the market to perform a wide variety of jobs. Principle of operation for these cylinders is essentially similar. Differences in design will be found in material selection, finishes, sealing methods, porting arrangements and general assembly features which may emphasize ruggedness, simple maintenance, low cost or convenience in adapting to your special application.

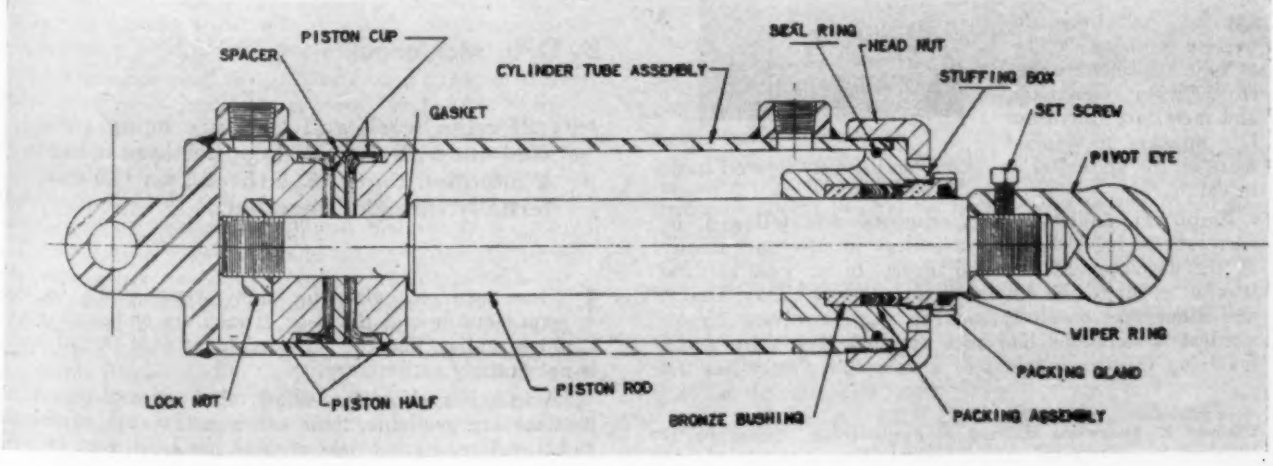
Cylinders may be either double or single acting. A double acting cylinder will reciprocate in both directions under action of oil pressure, while a single acting cylinder exerts a force in only one direction developed by oil pressure, and returns by the force of gravity or mechanical spring pressure.

Most commercial cylinders are single ended, having a rod extending from one end only to move the load. Double ended cylinders may have a load attached to both ends of the piston rod which extend out of the cylinder housing.

Because of simplicity of manufacture, most cylinders are an assembly of four major parts: cylinder

Continued on page 56

Fig. 3. Design of a double acting cylinder with a clevis mounting. Cup packings are used for the piston seal. One end cap is welded; the front cap is threaded to the body and sealed with an "O" ring.
Courtesy Hydraulic Equipment Co.



A Special APPLIED HYDRAULICS Report:

Abstracts from National Conference on Industrial Hydraulics

On the following pages are the highlights of papers presented at the 1951 National Conference on Industrial Hydraulics, held in Chicago during the second week of November. This report includes those papers which are related to problems and components found in fluid powered machinery. Complete papers will appear in the Conference Proceedings to be published in March 1952.

The Need For Basic Research in Hydraulics

By Thomas K. Sherwood

Today the field of hydraulics depends more on a "cut-and-try" approach than it does on basic research. Support of basic research is an effective method of expanding the industrial applications of hydraulics.

BASIC research in hydraulics has demonstrated its effectiveness in providing the reservoir of concepts, principles, and correlations from which, by deduction, it is possible to obtain the explicit answers which the engineer must have. It is suggested that the support of basic research is, in the long run, a cheap and effective method of developing the field of hydraulics and its industrial applications. In comparison with such fields as industrial electronics, industrial chemistry, and metallurgy, hydraulics appears to depend more on the empirical approach, and to rely less on basic research.

Empirical studies and experiments are followed by correlations based on dimensionless groups and finally by the development of sound theory. In the case of fluid friction in pipes, the empirical formulas of Chezy, Darcy, and others are obsolete, and the stage involving dimensionless correlations has been reached. The third stage, involving the development of a complete theory has not been reached. Comparison of modern textbooks with those of a generation ago indicates the great progress along this line in many branches of hydraulics, but too many are still in the empirical stage.

We do not understand turbulence, or have a sound theory of friction in turbulent flow. We know too little about the mechanism of the development of cavitation, and its effect on metal parts. Fuller knowledge of flow conditions near the walls of conduits would make it possible to relate heat transfer, mass transfer, and fluid friction. The effect of wall roughness is little understood, and we have no adequate technique of measuring roughness. The flow properties of slurries and non-Newtonian liquids are not known. Transient flow phenomena need much study, probably with the aid of modern electronic computers. The exceedingly important subject of multiphase flow through porous media is in a very early stage of development.

Basic research can more than pay its way in the assistance of industrial development and test programs. More is necessary to meet the needs in industrial hydraulics.

Thomas K. Sherwood is Dean of Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Control of Leakage by Use of Close Tolerance Thread Tapers

By D. B. McConnell

Design work and tests are being carried out with threaded connections using a modified taper pipe thread on the externally threaded member.

IT has been recognized for many years, both by the manufacturer and the user of medium and high pressure hydraulics, that the standard taper pipe thread joint is not entirely satisfactory.

While it is realized that many other types of pipe connections are available, their use is not always practical, and therefore, a great deal of work has been done to pro-

duce a better pipe thread. The Joint Industry Conference on Industrial Hydraulics spent considerable time discussing this problem and realized that no immediate solution was available.

Recognizing the importance in interchangeability in existing equipment as a necessity, and utilizing to a great extent the engineering development that has been expended on taper thread joints, the discussions in this paper may offer a practical solution to the various problems involved.

In this new approach the internal thread conforms in all respects to the national standard NPT. The external threads, however, while maintaining the NPT thread contour, have certain changes incorporated which provide the necessary characteristics to form a tight joint.

Tests to date with more than one size of standard tapped NPT holes which showed definite signs of leakage when plugged with standard NPT pipe plugs, have sealed perfectly with plugs made in the revised form. Also standard holes in new equipment have sealed perfectly with the original installation of the revised form plugs.

All tests have been conducted without the use of any compound (or pipe dope) and although testing of all sizes under all contemplated pressures are not yet completed, it is evident that torque applied bears a direct relationship to the pressure which can be retained without leakage. Although very high unit loading is accomplished to provide a seal, the torque appears to be lower than is normally used with standard NPT components.

D. B. McConnell is liasion engineer, Vickers, Inc., Detroit, Mich.

Low Temperature Hydraulic Fluids

By J. C. Mosteller and J. B. Shipp, Jr.

High speed aircraft and guided missiles have given impetus to search for fluids capable of withstanding the extremes of a -65 to 450 F temperature range.

HYDRAULIC fluids are used in military aircraft for the actuation of landing gears, wing flaps, brakes, bomb bay doors, and many other types of actuating and dissipating mechanisms, all of which are required to operate not only at normal temperatures but at —65°F.

The development of the presently used mineral oil base hydraulic fluid evolved from service experience with fluids composed of either petroleum fractions or castor oil. The hydraulic fluid used by the USAF today is suitable for use between —65°F and +180°F which represents an advantage of 45°F in low temperature operation as compared to fluids used prior to World War II.

Today the Air Force is conducting a systematic search for materials of unusual properties capable of withstanding the extremes of temperatures and operating conditions brought about by the trend toward high speed aircraft and guided missiles. Further, the desire for nonflammable fluids suitable for use between—65°F to 250°F has brought about the evaluation of materials possessing nonflammable characteristics. Several hundred materials have been synthesized and evaluated to determine their suitability for hydraulic fluid base stocks. These include glycol water mixtures, phosphate esters, esters of caboxylic acids, carbonates, borates, polyglycols, polysiloxanes, silicates, and halogen containing compounds.

The studies accomplished to date in the evaluation of the sundry of compounds and fluid blends indicates that considerably more research and development effort is necessary before a fluid suitable for use between temperatures below —65°F and 450°F can be realized. Not only is it necessary to improve certain of the properties of these compounds, but it will also be nceessary for engineers to design equipment capable of taking full advantage of the exceptional properties exhibited by many of the synthetics while at the same time compensating for those undesirable properties incapable of being improved through modification of chemical structure.

J. C. Mosteller and **J. B. Shipp, Jr.** are assistant chief and chief of Petroleum Products Branch, Materials Laboratory, Research Division, Wright Air Development Center, Dayton, Ohio.

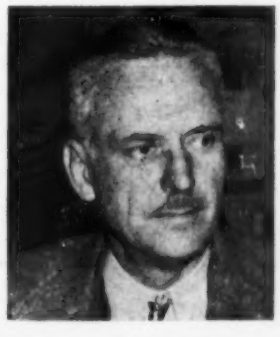
Opinions expressed are those of the authors and do not necessarily express the official opinions of the US Air Force or the Wright Air Development Center.

Hydraulics as Applied to Industrial Trucks

By Charles S. Schroeder

Applying oil power to industrial trucks offers advantages in cost, maintenance, and space saving as compared to electrical motor control. Simplicity of control, safety and accuracy are readily obtained.

THE industrial truck both gas and electric has now become an indispensible tool of industry and for the armed forces. The functions demanded of the vehicle can be classified in broad types which cover pretty much the state of the art today. The use of hydraulics in this type of equipment may be credited as a major characteristic of design that has made it possible to serve these varied functions as efficiently and effectively as is the case in today's modern truck. It is granted that many of these functions, both primary and auxiliary, could be served by electrical and mechanical devices, but for economies of design and simplicity of construction, hydraulics seem to lend themselves best to the functions involved.



The basic functions in which hydraulic transmission of power can be effectively applied may be listed as follows:

1. Hydraulic drive for propulsion of the truck, such as through fluid couplings or hydraulic pumps driving a hydraulic motor.
2. For hoisting the load.
3. For tilting the load-carrying channels forward or backward.

4. For clamping loads so as to eliminate pallets or platforms.

5. For side shifter devices which accurately spot loads into position.

6. Push-off and pull-on devices for automatically loading or unloading the material carried on the forks of the truck.

7. Rotating devices for upending loads or for turning them on their side.

8. Hydraulically operated scoops or shovels for handling bulk materials.

9. Hydraulic steering devices for heavy capacity trucks.

The operation of the hydraulic system in practically all trucks is similar but varies widely in capacity. It may be well to point out that industrial trucks are built in capacities ranging from ½ ton to 50 tons, requiring a corresponding range in the size of the hydraulic equipment employed.

It will be found that in practically all cases each machine will be required to perform at least two auxiliary functions, such as hoist, tilt, clamp, rotate, etc., and in many cases three or four, or even five. It is on these multiple functions that we find the first important advantage of hydraulics over other means of power transmission. The hydraulic system requires only one pump to supply the power source for each of the various functions. In the case of electric trucks, only one electric motor is required to drive this pump. By the use of a multiple spool valve, as illustrated below, the pressure flow from the pump is diverted to operate any one of the multiple functions by operating the proper control lever. When this is done the remaining functions are not disturbed but are held status quo in the blocked position by the spools in the valve. In other words, if the load is being clamped, the clamping action will not be disturbed when the load is raised or tilted or rotated.

If each of these functions were to be operated by independent electric motors, several motors would be required as well as multiple control devices and gear reduction units. The cost of these motors would greatly exceed the cost of a multiple spool control valve on the hydraulic system, and in addition, the cost of maintenance would be greater. Further, since overall size must be held to a minimum on industrial trucks, the space required by all these motors would be very undesirable.

A second advantage of hydraulics in industrial trucks is the opportunity it gives for controlling or limiting loads and overloads. It is a simple matter to limit hydraulic pressure to a predetermined value with a pressure relief valve. This characteristic can, in an approximate way, limit the lifting ability of a truck to avoid excessve overloads.

The third advantage in favor of hydraulics is the simplicity in controlling the limit of motion in any of the functions. Where such functions as hoist and tilt are powered by straight electrical or mechanical devices, it is necessary to provide limit switches which will shut off power to prevent overtravel and damage to the truck. With a hydraulic system, however, such limit devices are not necessary as we can come to the end of a cylinder stroke without fear of damage to the mechanism. Upon reaching this limit the pressure relief valve opens and prevents overstressing. At the same time, through the noise it produces, the valve warns the operator that the limit of travel has been reached, at which time he can return his valve to neutral.

Charles S. Schroeder is director of engineering, Yale & Towne Mfg. Co., Philadelphia Division, Philadelphia, Pa.

Hydraulic Power Steering

By W. A. Hunter

Care in the manufacture and assembly of components along with proper circuit design results in an automotive power steering system which is free from noise and vibration.

STEERING by brute strength is an anachronism in today's modern automobile. Increased front end weight and broad low pressure tires have increased the work of steering to the point where it is decidedly an unpleasant chore to park a car. Enough energy is expended in parking a car once to start the engine three times with a hand crank. The effort cannot be reduced by increasing the gear ratio without adversely affecting the response and safety at high speed. "Road feel", "fast response", and "finger tip" ease of control all contribute to safer steering. Chrysler hydraulic steering retains the important "road feel" (but reduces it 88%) "faster response" (40% less steering wheel movement) and "finger tip" control (12% of torque output is manual and 88% hydraulic) and in the case of power failure the car can still be steered manually through the conventional gear.

Essential parts of the unit are a conventional steering gear, a valve mechanism, a servo cylinder and pump. The servo control loop consists of valves, actuated by the relative movement of two spur gears connecting offset portions of the steering column shaft, connecting oil lines and a servo cylinder incorporated in the gear housing operating the cross shaft through a piston and power arm. Source of power for the unit is a 6 X 7 lobe Gerotor pump mounted directly on the end of the generator and driven at generator speeds.

The most difficult problems encountered in the development were the elimination of noises and vibrations. Pump noises were reduced by:

1.) Careful attention to manufacturing and assembly accuracy such that gear centers and like dimensions would not be adversely affected by misalignment, clearances, or structural deflections,

2.) use of two pumps with common inlet and outlet with rotors phased 180° apart as regards pressure pulses,

3.) flow control valve to limit flow through the restriction of the gear,

4.) satisfactory arrangement of the return line to facilitate rapid purging of any air from the system,

Continued on page 68

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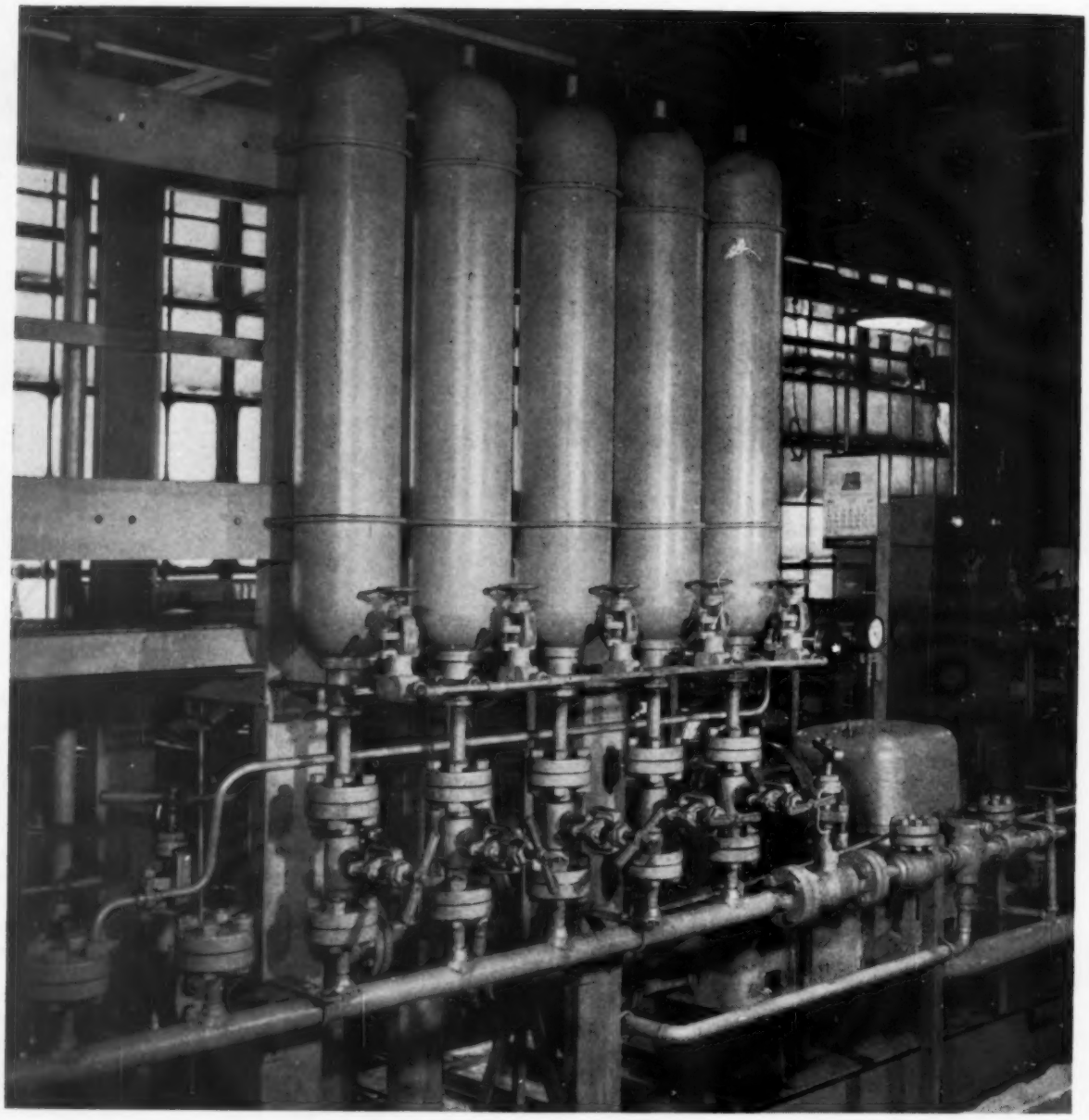

Design with

CENTRAL ACCUMULATOR SYSTEMS

for multiple station operation

As steel scrap comes off the slitting machine it winds onto a mandrel within a cast ring. To remove the finished scrap ball a hydraulic cylinder retracts the mandrel and a second cylinder actuates the paddle-like extractor, seen above the mandrel, to drop the ball to the floor.

By Leonard Melcarek

Here's a shop which was confronted with the problem of selecting an oil power source. They had two individually powered hydraulic machines and were planning to add nine more identical units. Should they add nine more pumps and drive motors? Or would a central system be more economical?

OIL power delivered from a central accumulator system is used on a clever but simple steel scrap collecting system at Acme Steel Company's Riverdale plant.

Originally, Acme built two scrap collecting stations. Each station used its own pump and drive to retract the scrap winding mandrel and actuate an ejector paddle.

Briefly, here's the system for getting ribbons of scrap into compact balls, weighing about 90 pounds, with an end result of greatly simplifying problems of space and handling of steel scrap. This scrap which comes from a slitting operation is collected on a spindle, gathering into a ball inside a cast ring. As soon as a large mass of scrap has been collected, the spindle is retracted. The ball of scrap is then forced to the ground by a paddle-like extractor. Both spindle and extractor are operated hydraulically. A 6 in dia, 20 in stroke cylinder retracts the mandrel and a 4 in dia 9 in stroke cylinder works the paddle.

The question of selecting a new power source came up when Acme decided to increase the number of scrap collection systems from two to eleven. When using only two stations each pump operated continuously through open center valves. A complete operation at each station occurs every ten minutes. Obviously oil pressure is only needed a small part of the time. Therefore, there is plenty of no-work time in which to charge an accumulator system with a small volume pump.

Five accumulators each having 10 gallon capacity were selected. One of the two pumping units used on an original station is used to charge the accumulators. The second pumping unit is kept as a standby.

In operation, the pump charges the accumulator system with oil to the required pressure of 900 psi. When the accumulators are charged, oil is circulated through an unloading valve back to the reservoir at almost zero pressure. This allows the pump to idle, keeping the oil cool and saving power as in an open center circuit. With these advantages, the system has provided the required speed of operation for both the spindle and extractor.

Actual cost of the accumulator installation was approximately $1,500 with an additional cost for the unloading valve, shut-off valves, closed center selector valves and new piping. However, the saving in cost over alternate circuits considered has been estimated at $4,000. Reduction in power consumption through the elimination of additional pumping units amounts to an approximate saving of $6,000. With fewer pumps and motors to service, maintenance has been minimized making the investment a key to profitable and efficient operation.

Leonard Melcarek is a design engineer with Acme Steel Company, Chicago, Illinois.

SAE A-6 Committee Holds Largest Meeting

THE SAE A-6 Committee, Aircraft Hydraulic and Pneumatic Equipment, held their semi-annual meeting at the Statler Hotel, Washington, D.C., on Wednesday, Thursday and Friday, October 24, 25 and 26. B. R. Teree, chairman, presided over the largest number of airframe, Service and industrial engineers yet to attend. A total of over 150 attended the first session.

The first morning was given over to the Hydraulic System Materials Subcommittee, now an integral part of A-6 and Fred O. Hosterman held the gavel.

Nonflammable Fluids:

The discussion of Nonflammable Fluids brought out a number of interesting facts. Mr. Sommers, BuAer, reported that H-2 (MIL-F-7083) did not separate in qualification tests in mockups at 200 F; and that tests at 220 F will be made. Leo Chattler, BuAer, reported that a preservative added to H-2 did not change the operating characteristics; that approximately 1650 Navy planes have had up to 600-700 operational hours with trouble only in one series. He reported that spherical bladder type accumulators were being replaced with cylindrical accumulators.

Chattler, in discussing the Packing Swell problem with H-2, stated that BuAer tests indicate that the swell is less than 15 percent, the allowable figure, and that BuAer is accepting all QPL rings. He said that no complaints have come to his attention on H-2 fluid. Dwight Leach, Chance Vought, reported very satisfactory service.

Carl Sadler, Sundstrand Machine Tool Co., reported that 2000 hours of operation of H-2 in a constant speed drive had not been detrimental to a magnesium casing. However, he did report some failures of highly stressed parts, particularly roller bearings, at 400 hours. Very good results were obtained at moderate wear (push rods, pumps, etc.); the wear characteristics were considered better than AN-O-366 at temperatures of 140-160F.

Harry Cornish, Douglas Aircraft Co., El Segundo, reported that H-2 had adversely affected leather backup rings. BuAer promised further tests on leather. Mr. Langer of Linde Air Products Co. asked that the spec be simplified.

Lt. Hess, ADF, reported on the status of the Materials Laboratory tests on fluids being developed to meet MIL-F-7100. The major testing is being done on the silicate group, using a base fluid, additives and snuffers. Mockup tests are to be made and reported at the next meeting.

Frank Murphy, Douglas Aircraft Co., Santa Monica, reported that troubles encountered with Skydrol fluid in wing flaps and shock struts had been corrected by Teflon backup rings.

High Temperature Hydraulic Systems:

Jack Prete, ADF, reported that diester and silicate type high temperature fluids were running in mockups. E. R. Bartholomew, ADF, stated that high temperature rubber tests were in process, chiefly on silicate types.

Frank Mittell, North American Aviation, stated that he needs both fluids and packings now for

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higher operating temperatures. Frank Murphy told of AN-O-366 tests to 300 F, using high temperature rubber and Teflon backup rings. Jack Prete stated that the present fluid could be used up to 180 F; that tests up to 250 F had only gasket (AN-902) failures at 5000 cycles. A limited amount of testing at 300 F at 30 cycles with one hour intervals for cooling is being done.

The chairman appointed a committee to continue the study of high temperature systems. Frank Murphy, chairman, Harry Cornish, Ralph Middleton, Frank Mittell (with a representative of North American's Downey operation) and Howard Field, Jr. are the members.

Packings and Gaskets (MIL-P-5516):

A supply representative of ADA stated that it was contemplated that "O" rings be required to be packaged individually. Discussion developed that a number of undesirable installation habits were developing out of the present packaging practices. Frank Murphy pointed out that Douglas has been doing their own packaging.

The discussion on the proposed elimination of the color dot identification for "O" rings developed that the airframe industry wants the dot retained. Jack Prete, advised that the AF study was still incomplete.

Harold Berke, in reporting on "O" ring spiral failures on outrigger shock struts, stated that "V" rings eliminated failures. Both Cornish and Middleton reported spiral failures, Middleton citing an increasing number in the past year. An obstacle is the great difficulty in reproducing failures in the laboratory. Dwight Leach quoted an old report that indicated that concentricity was the main cause of spiral failures.

Backup Rings:

Jack Prete stated that the AF considered the permanent color identification of leather backup rings as desirable. J. N. Smith of E. F. Houghton & Co., repeated a request made previously for a double color identification, one side for the tanner, the other for the packing manufacturer.

Special Low-Friction Seals:

The discussion developed several facts. Harry Cornish reported that a standard chevron of 70 Shore (instead of 90) developed less friction than a standard "O" ring in 3000 psi tests; Ralph H. Skinner, Jr., Skinner Motors Co., confirmed this by citing tests of a nylon chevron, which developed only 1/5 the friction of a standard "O" ring at temperature ranges from —65 to 250 F at pressures up to 3500 psi. Don Driskell, Haskell Engineering & Supply Co., reported that by buffing off flash of "O" rings, friction was cut approximately 40 percent. Fred Pollard, Republic Aviation Corp., stated that he had used a two piece piston ring with very satisfactory results.

Pneumatic System Lubricants:

Harold Berke reported that the new pneumatic grease Number 81197, which meets MIL-G-4343, is available in increasing quantities from General Electric. He reported that it was superior to AN-G-15.

Allowable "0" Ring Squeeze:

Frank Murphy, reporting on a survey among the airframe companies on the allowable "O" ring squeeze for both static and face seal applications, stated that the majority believed that the squeeze should not be increased.

Solenoids Integral with Hydraulic Units:

Fred O. Hosterman, Weston Hydraulics, Ltd., pointed out a difference in dielectric strength test requirements between MIL-S-4040 and SAE-A6-40 and asked for standardization. Berke will check.

Hydraulic Pressure Relief Valve:

Harry Cornish presented the results of a survey among NASC and relief valve manufacturers to determine: (1) if reverse flow is desirable for the cylindrical type of relief valve and (2) to consider an envelope drawing. Considerable discussion ensued and the chairman appointed a committee of airframe and valve manufacturers, chairmanned by Ralph Middleton, to work out a solution.

Leo Chattler requested a discussion of the effect of back pressure on the original relief valve pressure setting. Considerable discussion developed among S. E. Sanfilippo, Ralph Middleton, John W. Kelly, Mike Caserta and Milton Kidd. The chairman asked that a West Coast committee continue this study.

Hydraulic Filters (MIL-F-5504, AN-F-3):

H. E. Otto, Purolator Products Corp., requested that permissible leakage on 3000 psi line filter relief valves be raised from 1 cc to 2 cc per minute at 70 to 80 psi for full flow pressure. This was approved. R. N. Stickney reported that qualification tests only were holding up the issuance of both 1500 and 3000 psi filter specs. Mr. Otto asked for a check among airframe companies to determine if a preference for reservoir filters for inside out flow or outside in flow exists. Discussion disclosed that most airframe makers want the inside out type.

Aircraft Hydraulic Pressure Accumulators (MIL-A-5498):

R. N. Stickney reported the revised spec had been approved by both services and sent to Aircraft Industry Association (AIA). The use of AN 6287 air valve with AND 10050-5 boss on cylindrical accumulators was discussed at length but no action was taken. Harold Berke raised the question of the use of a needle valve for bleeding accumulators. The question of standardization was discussed. Lee H. Schmohl, The Parker Appliance Co., accepted an assignment to coordinate through committee A-3.

Swivel Joint (MIL-J-5513):

Harry Cornish requested a discussion of (a) vibration test requirements and (b) the status of previously proposed torque increase recommendations. At the chairman's request Cornish will prepare changes as agreed by the committee. Stickney will check on the allowable torque increase.

Hydraulic Self-Sealing Coupling (MIL-C-5502):

R. N. Stickney reported that tests on four types of couplings were in the hands of BuAer for test. S. E. Sanfilippo said tests would be run soon. Sanfilippo also was given the problem of finding an answer for R. Y. Irwin, Northrop Aviation, Inc., who asked about the inadvertent shutting off of Aeroquip self-sealing couplings in the assembled condition. Al H. Hoblemann assured Irwin that self-sealing fittings could be used in pneumatic systems.

Flow Regulator Valves:

John W. Kelly, Adel Div., General Metals Corp., distributed copies of a survey. Some changes were indicated and approved. The data is to be resubmitted to the airframe companies for concurrence.

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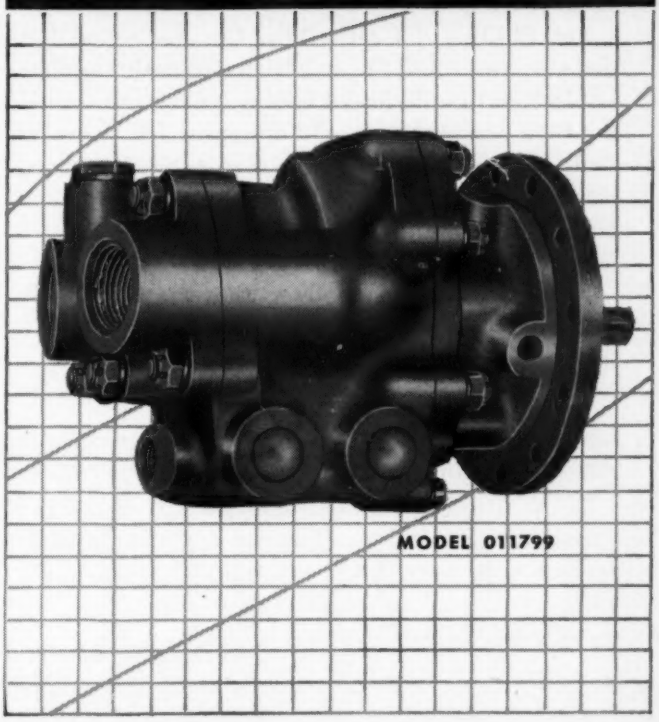

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Tubing and Fittings:

Harry Cornish distributed copies of a study on the weight of titanium hydraulic tube installations. In addition to weight and price comparisons with steel tubing, properties, availability and recommended tests for tube installations were given. It is hoped that titanium tubing will be available in three years.

Bob Phillips of Weatherhead Co., had asked that the question of 61ST and high strength stainless (AMS 5566) be discussed because of the position of the fitting manufacturer in designing for either or both. Harold Berke stated that 61ST had been causing too much trouble and that quarter and eighth hard stainless for replacement was satisfactory.

F. F. Jacobs, BuAer, stated that the tests being made on stainless were in progress and the chairman asked for a report at the next meeting.

Bob Phillips distributed a survey on cluster fittings made by the Weatherhead Company.

Air Check Valve:

K. H. Brown, Kohler Company, distributed copies of an envelope drawing for check valves for use with both AND 10056 and 10050 connections. This was approved and forwarded to the Pneumatic subcommittee and NASC.

Air Control Valve:

Dwight Leach presented the results of a survey through the NASC regarding the revised spec and envelope drawing. Discussion developed that the spec was satisfactory in the main but considerable argument developed over the size of the envelope.

Pneumatic Systems; Design Installation and Tests in Aircraft (MIL-P-5518):

At the request of Leo Chattler, Dr. M. Slawsky reported on the status of the testing work being done at the Bureau of Standards for BuAer. This program, pointed immediately at a Service special program, is expected to run for four or five years and cover a very considerable body of basic pneumatic research as well as practical aid in the design and testing of pneumatic components.

Al H. Hobelmann reported on the status of the specifications on the pneumatic relief valve and pressure reducing valve specifications being prepared by the Pneumatic Subcommittee. A check was made so that all interested pneumatic valve manufacturers would receive preliminary data.

Chairman Teree announced that Paul A. Hartline, Transworld Airlines, Inc.; Phillip Musa, Grumman Aircraft Engineering Corp.; and Ralph Middleton, Lockheed Aircraft Corporation had become members of A-6 Committee.

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Aircraft Pump Committee Meeting

CHAIRMAN J. Milton Kidd, Glenn L. Martin Company, called the SAE Aircraft Pump committee A-1 to order at nine o'clock Tuesday morning, October 23 at the Statler Hotel, Washington, D.C. In addition to a number of pump problems, the Electric Motor Standardization was reported by sub-committee and a report on air compressors was made, the latter the first such report on the committee agenda.

B. R. Teree reported on the progress made by a panel of representatives of pump manufactures on *Port Size Standardization for Hydraulic Pumps.* Frank Mittell, North American Aviation, Inc., reporting for R. C. Bumb on the results of the North American survey circulated to pump manufacturers, presented the recommendations of scavenger and pressure port sizes. The recommendations were approved by the committee and forwarded to the Services.

Pressure Pulsation Test

Carl Sadler, Sundstrand Machine Tool Co., reported on a proposed change in the *Pressure Pulsation Test* in the *Variable Delivery Pump Specification.* Instead of a solenoid cut-off valve, as originally considered, it was proposed that the bottoming of a cylinder be used to cause pulsations in the test rig. This is intended for use in the Maximum Cut-Out Transient Pressure Test. The details of the cylinder will be worked out by Carl Sadler and Milton Kidd and reported at the next meeting.

H. M. St. John, Hamilton Standard Div. United Aircraft Corp., representing committee member R. F. Horton of the same company, reported on the results of a survey on *Hydraulic Power Driven, Variable Delivery High Speed Pumps* made among NASC (National Aircraft Standards Committee) members. Since only minor changes were recommended and accepted, the completed report was accepted and will be forwarded to Aeronautical Standards Group (ASG).

Kenneth Postel, Vickers, Inc., chairman of the sub-committee on *Electric Motor Standardization* reported again on the feasibility of using standard electric motors on electric motor driven hydraulic pumps. The most important decision arrived at, after considerable discussion on the whole problem, was that female drives be used for pumps and male drives for motors. The increasing importance of high speed pumps was also discussed.

R. P. Loveland, General Electric Company and chairman of *Motor Standardization Panel Committee A-2,* again present by invitation, discussed the efforts of his committee; particularly helpful was data on the selection of motors and pads for high speed hydraulic pumps.

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Dwight Leach, Chance Vought Aircraft, reported on *Pump Drive Couplings*. A number of airframe companies have been having trouble, apparently due to fatigue failures, since shear strength appears to be adequate. Pump manufacturers were asked to check this problem further.

Dwight Leach reported that two changes in coupling configuration design have practically eliminated drive coupling troubles at Chance Vought.

J. F. Murray, Thompson Products, Inc., who reported on *Fuel Pumps*, stated that a new spec was issued about ten days previously. He suggested that a study be continued on the effects of air and fuel mixtures on pump performance.

M. Caserta, M.C. Mfg. Co., reported briefly on his *Air Compressor Survey*. This is reported in some detail in the section on the Pneumatic meeting.

Chairman Kidd announced that H. M. St. John, Hamilton Standard Div. United Aircraft Corp., has accepted appointment as a new member of the committee.

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Capable of Output Fluid Pressures to 50,000 PSI. from 100—150 PSI. Plant Air Supply. Thousands in service. Broadly applicable for hydrostatic testing, for powering presses for metal forming, shearing, clamping, for jacks, pullers, bending cylinders, etc. A selection of models by ratio is available. Capacities from 3,500 to 30,000 PSI. are standard. Higher capacities are special. For either oil or water service where low volume output at high pressure is the requirement. Model 216-C illustrated, left, measures 8¼" wide x 9⅝" deep.

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A-3 Committee Meeting

SAE Committee A-3, Aircraft Valves, Fittings and Flexible Hose Assemblies was called to order by chairman Les J. Henderson on Monday, October 22 at the Statler Hotel, Washington, D. C. The number of items on the agenda necessitated a separate meeting on Tuesday at which the large size tube fittings were discussed.

J. I. Detwiler, Lockheed Aircraft Corporation, reported for Ralph Middleton on a proposal for changes in the **Standard Swivel Fitting Assembly** (AN 775 bolt, elbow fittings AN 776, 777, 778 and 779). The written proposal submitted proposed to seal the AND 10080 installation by replacing the crush washer between the universal elbow and the AND 10050 boss face with an AN 6290 "O" ring. This necessitated one simple modification of the AN 775 bolt to provide an "O" ring groove. The AN 901 washer between the elbow and the AN 775 bolthead is retained. The modification is for use where space is critical. Detwiler reported that some leakage occurred in larger sizes, beginning with one-half inch. Frank C. Mittell, North American Aviation, reported that the old style assembly, used since 1946, has had no failures in sizes one-half inch and less.

Harold Berke, Air Development Force (ADF) reported limited testing of the Dowdy sandwich seal as satisfactory. Various airframe companies have been using their own designs. A subcommittee with Detwiler as chairman, and Frank Mittell; Fred H. Pollard, Republic Aviation Corporaton; and Harold E. Wells, Bell Aircraft Corporation, as members, is to coordinate and report back. Lockheed is to continue tests on the modified assembly.

R. W. Phillips, Weatherhead Company, reported on the prog-

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ress made on **AN 937, 938, 939 and 941 Fittings** with internal threads. Data on both aluminum forgings and extruded bodies were presented. Extruded bodies' gave longer life—one fitting failed at 105,000 cycles, another at 120,000 and a third is still running at 145,000 cycles. Smaller sizes have been tested at 3000 psi, with 150 percent peaks; tests on size 16 are to be made. Harold Berke suggested that centrifugally cast stainless steel bodies be investigated further, since early fittings performed so well.

Mr. Phillips also reported that the test furnace for conducting the hose fire test on **MIL-H-5511 hose, aircraft hydraulic, pneumatic, fuel, oil and coolant resistant,** has been received and set up and that actual testing would shortly be under way.

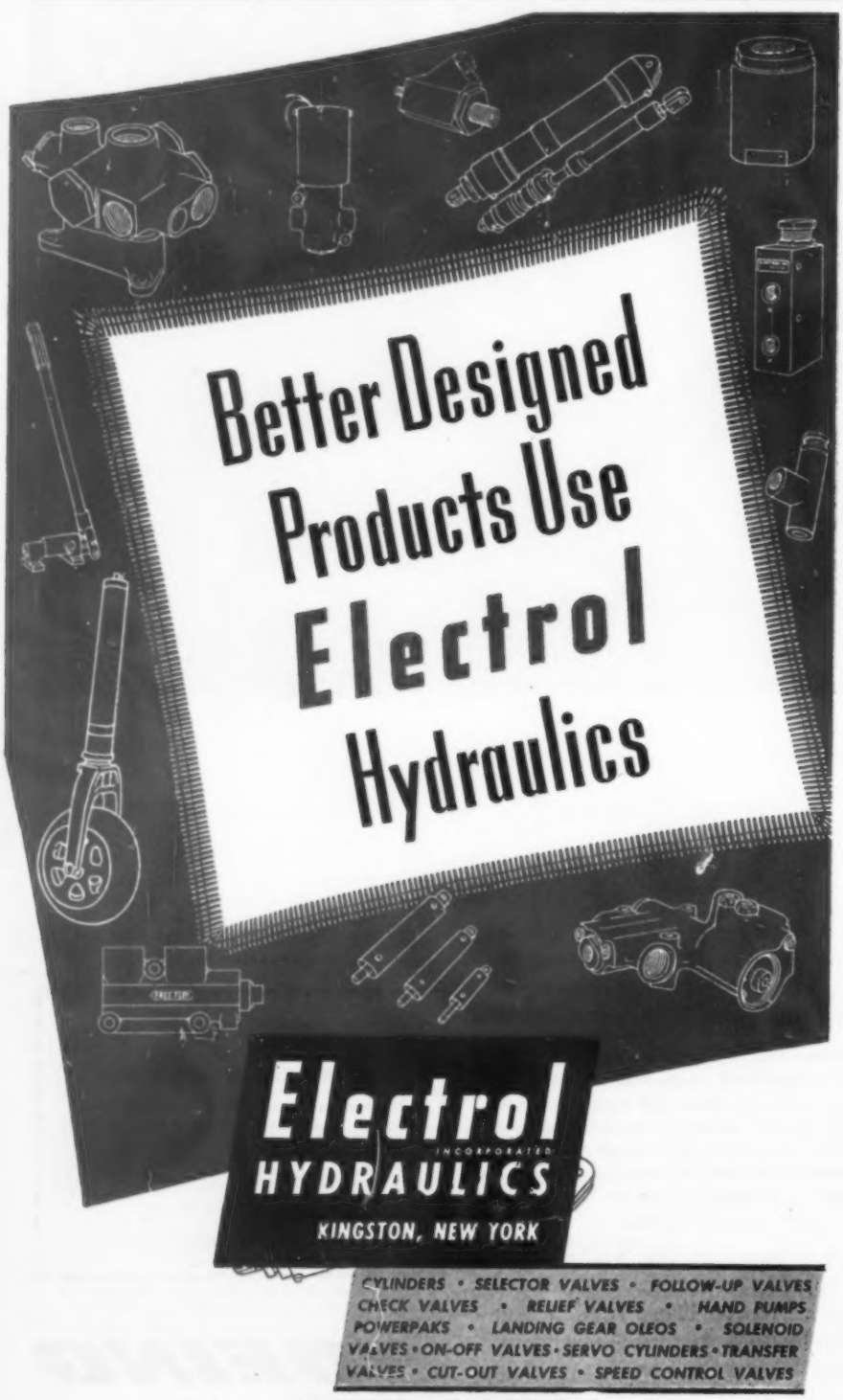
R. N. Stickney, Aeronautical Standards Group reported on several AN drawings, specifications and MIL specifications. Noteworthy was the change of angle of AND 10056 and 10057 to 45 degrees, finished dimension, to include rolled threads; disposition of cadmium plating of AN fittings; and the status of MIL-H-5511. With the Aircraft Engine Technical Committee (AETC) and the A-3 Committee both divided on cadmium, the chairman ordered the problem sent to the Services for decision.

J. J. Millard, United States Rubber Co., reported trouble on sizes -4 and -5 on single braid, 3000 psi hose tested at 125 percent peak (MIL-H-5511). Willard Haas, The B. F. Goodrich Co., reported no trouble in those sizes; Paul Hopkins, Electric Hose & Rubber Co., reported-4 size failures. R. W. Phillips reported failures of -4 and -5 hose sizes at less than 100,000 cycles. However, most hose ran 70,000 or more cycles. Jack Prete, ADF, reported one failure at 60,000 cycles in 5 or 6 tests run to date. The concensus of opinion was that MIL-H-5511 should be used unless definite peak problems were encountered; in which case MIL-H-5512 should be used.

Marking of Fittings

The **Marking of AN Fittings** was thoroughly discussed. A survey report was read by Lee H. Schmohl, The Parker Appliance Co., analyzing both metal and rubber markings and the problems involved for all AN hose and tube fittings. It was recommended that hex faces, boss or pad areas be marked. The report also included suggestions for sizes of markings and lists of groups of pad dimensions and space requirements for 5 character lines in both steel and rubber.

After considerable discussion is was agreed that six number AN series be added to the suggested marking recommendation and that the corrected report be turned over to Harold Berke and



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that copies be sent to all fitting manufacturers.

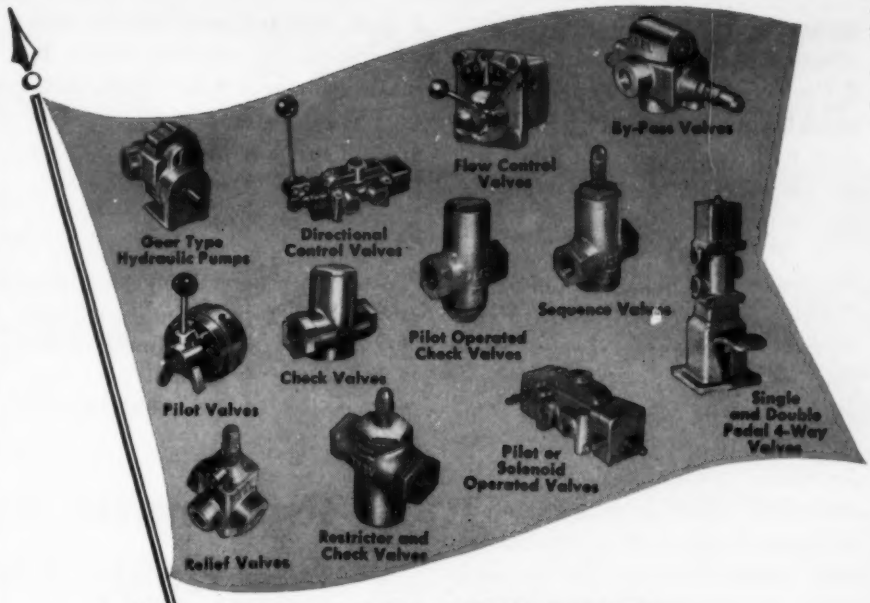
H. G. McIlroy, Roylyn, Inc., reported on a survey made on **Fuel and Oil Quick Disconnect Coupling.** Four manufacturers agree that a standard nipple nose could be made and the coupling made to fit it. The spec is ready and will be turned over to F. F. Jacobs, BuAer.

F. F. Jacobs, BuAer, reported on the status of the study on **Unified Threads for AN Fittings.**

Fitting Materials Not to be Down Graded

R. N. Stickney cited an NPA order given the Iron and Steel Committee on **MIL-F-5509A Fittings, Fluid Connections,** the status of steels approved for AN fittings, that there would be no down grading of materials for aeronautical parts without the consent of the Services. There is some movement, however, in the direction of alternate materials of minor variations from present accepted grades. For example, a recent Amendment accepts 1141,4140 and 8740 steels. Harold Berke, ADF, reported on the basis of incomplete tests, that a tensile of 80,000 psi, suggested by the mills, has been "less than desirable." These tests included lower torque values. Frank Murphy, Douglas Aircraft Co., Inc., Santa Monica, cited difficulties encountered with lower torques. Stainless steel and aluminum (17S and 14ST) were also reported briefly.

Harry E. Cornish, Douglas Aircraft Co., El Segundo, reported on the use of AN 6290 "O" rings in the **AN 924 Jam Nut Universal Fitting application, AND 10050,** for use with fuel and oil. This ring, suggested as a replacement for the AN 6290 volume gasket, is being tested at Douglas, chiefly in the smaller sizes. Due to the fragmentary nature of the testing done so far, no definite conclusions were reached. Harold Berke, ADF, reported that sizes 16 and 12 were marginal for holding



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pressures at -65F and 3000 psi. It was reported that Walter Kidde & Co. Inc., has been experiencing trouble in size 16 AN 10056 fitting with high pressure air. Linear, Inc. accepted the assignment to continue these tests.

H. P. Henderson requested a discussion on a paragraph of **MIL-C-5501A, Aircraft, Tubing Protective,** which specifies a new pressure of 10 psi for shipping enclosures in place of the old requirement of ½ psi. The lively liscussion which followed, led chairman Henderson to request a survey of the airframe industry and suggested that pump and valve manufactures also be included.

Ralph L. Skinner, Jr., Skinner Motors, Inc., at the request of the Aircraft Engine Committee (AE-1), demonstrated and diagrammed the new **Skinner Thin Flexible Seal** for high temperature and high pressure applications for aromatic fuels. The seal, designed for applications to 800 F and 1500 psi pressures, is .003-005 thick, of similar metal to mating surfaces it is to seal. Sealing by interference fit, against ground surfaces of approximately 16 rms, the seal was reported to be effective for pressures as low as 10 psi.

A second special meeting was devoted entirely to the discussion of **Large Size AN Fittings and Flanges.** J. S. Fitzpatrick, Boeing Airplane Co., as chairman of the subcommittee on Large Size Tube Fittings, reported on the survey made among the airframe companies. General agreement was reached to the effect that more extensive tests should be made. In addition to Lockheed, where tests are in progress, Douglas and Boeing will also test large size fittings.

J. H. Millar, Avica, Inc., submitted a report on flanges in sizes over three inches.

Pneumatic Subcommittee Holds First Meetings

CHAIRMAN Al H. Hobelmann, Walter Kidde & Co., of the Pneumatic Subcommittee appointed by SAE A-6 chairman Teree at the April Dayton meeting held three meetings of his group during the week of October 22-26 in Washington D. C.

On Monday, the 22, the subcommittee met with Service representatives to discuss pneumatic components and specifications for a critical program. This meeting, which was confidential, also influenced the discussions of the following meetings. The meeting lasted all day.

A second all day meeting was held at the National Bureau of Standards on Tuesday at the in-

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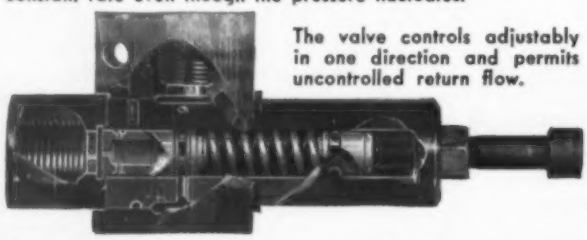

The valve controls adjustably in one direction and permits uncontrolled return flow.

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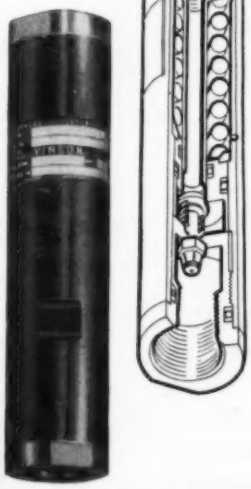

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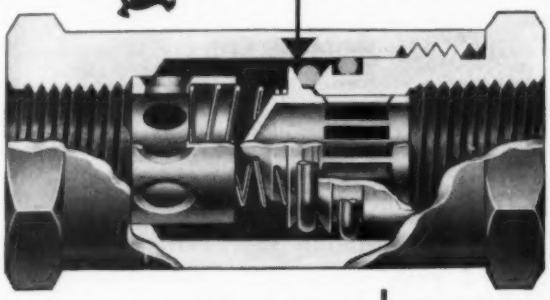

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vitation of Dr. M. Slawsky and Dr. Joseph Hilsenrath of the Bureau, both of whom are engaged in the BuAer pneumatic program.

The assignment given the Pneumatics subcommittee was to develop specifications for *pneumatic relief valves, pressure reducing valves* and *reservoirs.* At a special meeting called in June and held at Dayton, Ralph E. Middleton of Lockheed Aircraft Corp. and Fred H. Pollard of Republic Aviation Corp. attended by invitation to represent the airframe manufacturers. At that time it was determined to prepare a *general specification for pneumatic system components* and *proposed specifications on relief* and *pressure reducing valves.*

Relief Valve Spec.

At the NBS meeting the *proposed relief valve specification,* the draft of which was prepared by M. Caserta of M. C. Mfg. Co., was discussed at considerable length. Small changes were agreed upon on definitions, classes and pressure adjustment ranges. It was agreed that more study and testing would have to be done and the point of view of airframe manufacturers would have to be known before the specification could be developed further. However, it was felt that satisfactory progress had been made in the preliminary discussions.

Pressure Relief Spec.

At a third meeting held on Thursday evening, the *proposed pressure relief specification* was examined in detail. Discussion developed that considerably more work was necessary before the spec could be presented to the A-6 committee as a recommendation. L. A. Carlson, Westinghouse Air Brake Co., accepted the assignment of ironing out difficulties and changes suggested by the subcommittee members. It is hoped that the spec would be ready for the next A-6 meeting.

The members of the Pneumatic subcommittee are: Al H. Hobelmann, Walter Kidde & Co. chairman; J. W. Kelly, Adel Division, General Metals Corp.,; L. A. Carlson, Westinghouse Air Brake Co.; Carl Strid, General Controls Co.; Michael Caserta, M. C. Mfg. Co.; and N. L. Cornelius, Cornelius Co. Robert Thompson alternated as the Cornelius Co. representative.

Mr. Hobelmann reported briefly at the general A-6 meeting on the progress made by the Pneumatic subcommittee. The progress, incidentally, was sufficient for Leo Chattler, BuAer, to ask that a commendation for the subcommittee's work be included in the A-6 meetings minutes.

At the suggestion of Chairman Teree, the Pneumatic subcommittee will hold their next meeting separately from the A-6. Mr. Hobelmann had not designated the next meeting date and place when the last meeting adjourned.

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High Pressure Testing

Concluded from page 26

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Going over to the production machine, we applied a fixture very similar in design to the laboratory setup.

To generate the high pressure, we made use of basic principles of hydrostatic force multiplication. Our circuit uses standard hydraulic components operating at a very manageable 700 psi. This pressure applied to the blank end of the six inch cylinder results in a pressure of 25,000 psi on the one inch plunger diameter applied to the oil in the rocket body.

The cycle is started by limit switch action when the door is fully closed and ends several seconds later when a pressure switch and timer combination deenergize the valve solenoid to shift the control valve and retract the working plunger. At this stage, if the part is good, it is automatically stamped with a letter denoting first or second test.

Precision Timing of Tooling

Concluded from page 31

necessary smooth feeding of tools.

Timing of in and out motion of tools from the moment the start button was depressed had to be completely automatic. Much concern was given to the "bounciness" of air and variations due to temperature. Would conditions change from cycle to cycle preventing accurate timing?

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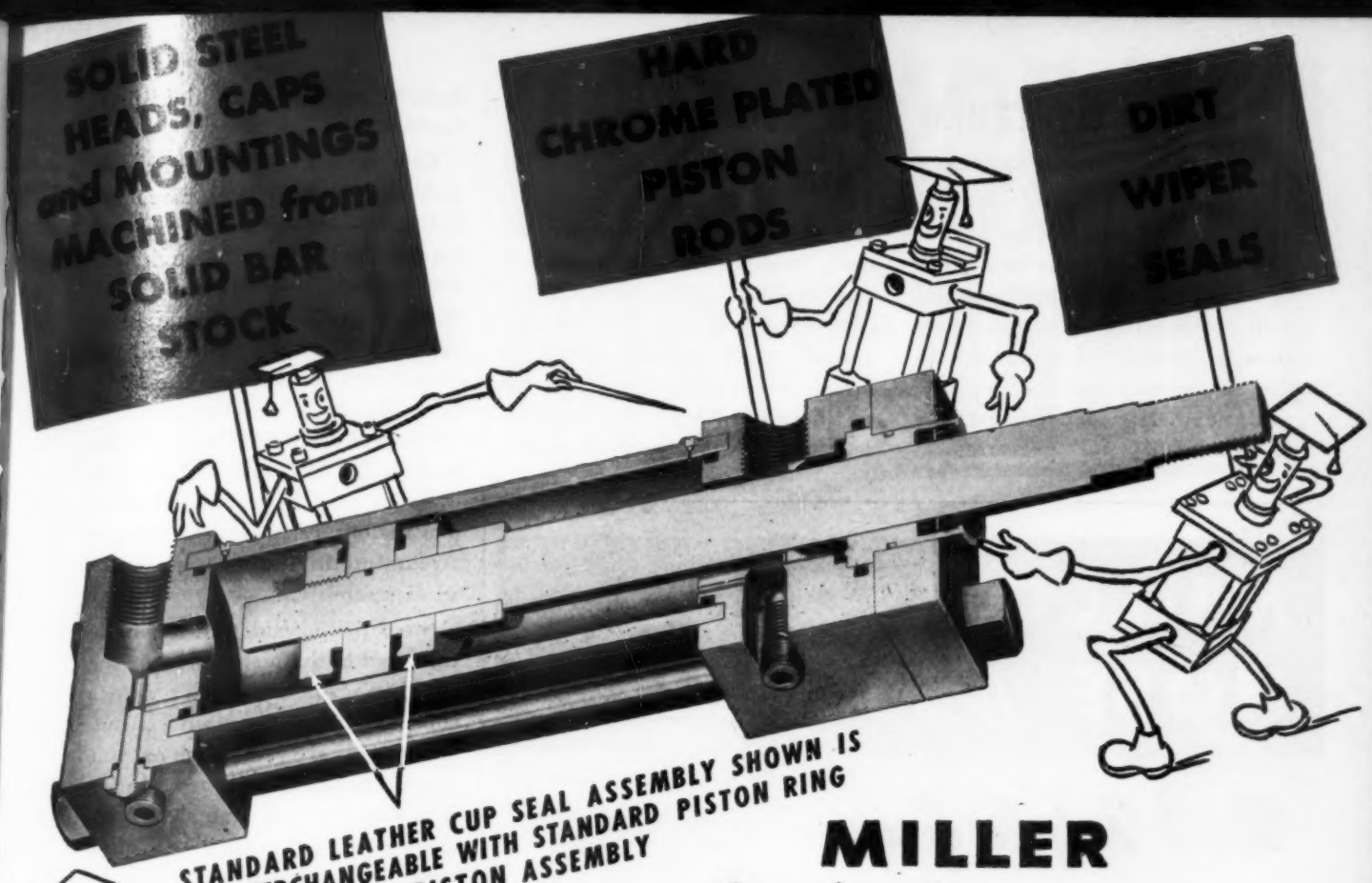

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Hydraulic Cylinders

Continued from page 35

body, two end caps and the piston. The cylinder body may be a piece of seamless steel tubing with a well finished bore or it may be an iron or steel casting in which case one of the end caps may be integrally cast. High tensile cast iron is satisfactory for pressures to 1000 psi, beyond that pressure cast steel, forgings or steel tubing is used. Cylinder size also is a factor in determining materials. For example, small cylinders below 4 inches in diameter may not be cast because it is not particularly economical, and small areas are usually subjected to high pressures.

One of the major differences between cylinder designs is the manner in which the end caps are fastened to the body. Some designs use tie-rods, others have bolted flanges, and some will have one cap welded to the body and the second cap threaded on the body. Several designs use internal keys or snap rings to hold the cylinder body to the end caps to give a true cylinder free from any bosses or protrusions. Easy removal of these circumferential keys permits rapid disassembly.

Steel piston rods are normally threaded in the piston head or the head is pressed on the rod to a shoulder and locked with a nut. Piston rods are often flash chrome plated to give resistance to scoring. Ratio of rod diameter to diameter of piston head is a question of desired strength and desired travel rates. Most standard units use a 2:1 differential piston rod which permits a stroke that is approximately double the speed of the out-stroke because the working area exposed to pressure oil is cut in half on the return stroke.

Efficient operation of cylinders largely depends upon the proper arrangement of packings and seals. These seals must prevent leakage from the end cap joints, leakage past the piston rod, washby between the high and low pressure sides of the piston head, and leakage through the rod connection in the piston head. A study of the accompanying cross-sections will show the application of seals at these critical points.

Standards established by Joint Industry Conferences call for the use of sealing devices that seal with pressure. Therefore, today packings are almost exclusively the self tightening or automatic type either "V" or "O" ring. Packings on the piston head are either of the automatic piston ring type or leather cup packings. The positive type piston ring seal gives long life, minimum slip or leak

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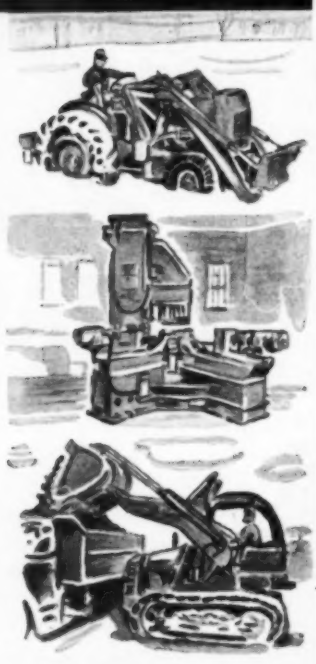

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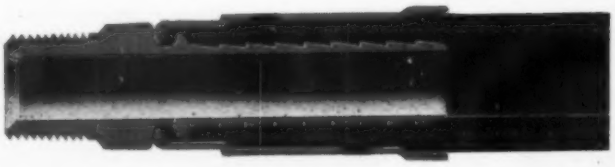

Cut-away view showing unique construction of "Press-Lock" Coupling. Note that entire hose wall is employed.

Three-way gripping efficiency is provided by the "Press-Lock" Coupling, as follows: Inner section of hose wall is pressed into corrugations on stem; outer hose wall, with reinforcing wire, is displaced under pressure into openings in coupling sleeve; sleeve is anchored to collar on stem, back of hex portion.

Because the **entire hose structure** is employed in attaching the "Press-Lock"—no part cut away—hose will withstand shock loads and continuous flexing far beyond the limits attainable by use of conventional type couplings for this service.

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age with low friction and is therefore preferred on many applications. High packing friction would reduce operating efficiency.

Since packings are most vulnerable to wear, they should be readily accessible for servicing.

Because of the many types of equipment in which cylinders are installed, a number of different mounting styles may be had. There are variations of flanged, foot and center-line mountings, clevis and trunnioned mountings make possible installations where movement of the cylinder body is required.

Cushions Ends of Cylinder Stroke

It is often necessary to retard the end of the piston stroke, either to perform some action at a slower rate of speed or to prevent hammering of the piston against the cylinder head. To accomplish this slow down of travel at the stroke ends, cylinders can be supplied with cushions built into either or both ends. Figure 2 shows one design for this purpose. In this case the cylinder is cushioned at both ends.

The degree of cushioning can be varied by adjusting the cushion needle valve. Cushioning results from regulating the flow of oil that is discharged from the cylinder while the piston is in motion. The length of cushion varies with cylinder bore.

Another feature found in many cylinders is air vents. Air in any oil system results in jerky piston travel. With an air bleed on the highest point in the system, air will be forced out by the action of the reciprocating piston.

Two distinctive cylinder designs, the telescoping and rotary, are available. The telescoping cylinder consists of several sections which provide a relatively long stroke from a short cylinder. The rotating type finds use in machine tool spindles and material winders for operating chucks.

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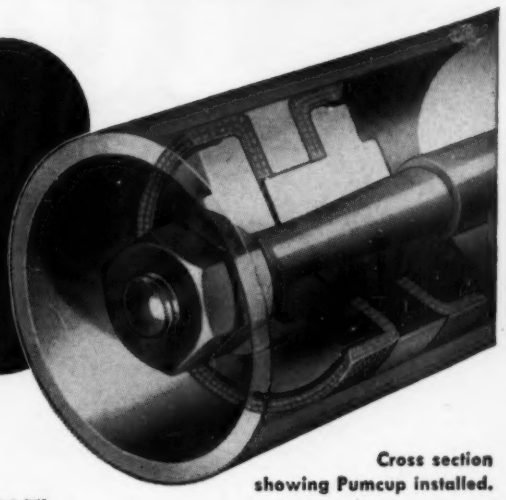
with
DARCOVA PUMCUPS



Cross section showing Pumcup installed.

NORMAL wear of ordinary packing reduces efficiency to a tremendous degree.

In contrast, Darcova Pumcups actually retain their efficiency . . . and they outlast most other packings at least 3 to 1!

Their scientific construction makes it possible to reach *and hold* peak efficiency. Under pressure Pumcups hug the cylinder walls to provide a uniform seal and exert full pressure where it is needed. This means reduced slippage, lower power costs and far less maintenance.

Write for helpful data-and-proof bulletins: No. 4502 on Pumcups for air and hydraulic mechanisms; No. 4401 on Pumcups for reciprocating pumps.

Cost-minded engineers in many industries have standardized on Pumcups to solve their packing problems. The list of successful applications includes the following installations:

Die casting machines
Forming and drawing presses
Straightening presses
Pipe bending machines
Briquetting machines
Pusher mechanisms
Door control devices
Lifting and dumping devices
Spraying equipment
Proportioning pump regulators
Recoil cylinders
Air booster pumps
Grease guns
Automatic bottling and filling machines
Extrusion presses
Steering mechanisms

DARCOVA
THE ORIGINAL COMPOSITION CUP

DARLING VALVE & MANUFACTURING CO.
WILLIAMSPORT 15, PA.

PUMCUPS

Circle 41 on Reader Service Card

Now 75 and 100 GALLONS PER MINUTE

100 g.p.m. Sump Type (Housing Cutaway)

with a single

MARVEL SYNCLINAL FILTER

(5 to 100 g.p.m. sizes)

ANSWERING DEMANDS FOR MORE! Ever since Marvel offered its first balanced synclinal filter eight years ago, a 20 g.p.m. model, industry has wanted more and more. Marvel Synclinal Filters reduced down time and cut maintenance costs. Industry's enthusiasm for Marvel Synclinal Filter's outstanding qualities was unprecedented; demand rose for a more complete range of sizes, and Marvel added 5, 8, 10, 30, and 50 g.p.m. models for most commonly required specifications. To add to the versatility of Marvel Synclinal Filters for a wider range of application, a filter enclosed in a housing for line application in hydraulic and in circulating systems was developed. Industry soon wanted still greater capacity units to eliminate multiple installations on machines needing even higher flow rates. Now Marvel again answers demand with new 75 and 100 g.p.m. sizes. The 75 g.p.m. model is only 12½" long overall, 6" in diameter, and the 100 g.p.m. model is only 14" long, 6½" in diameter.

Line Type (Cutaway)

FOR ALL HYDRAULIC AND LOW PRESSURE SYSTEMS

filtering non-corrosive liquids. All sizes available in meshes from 30 to 200. Operate in any position. Line models may be serviced without disturbing pipe connections.

Original Equipment of over 250 manufacturers

Write for further information and complete engineering data.

Meets J.I.C. Standards

MARVEL ENGINEERING COMPANY
625 W. Jackson Blvd. Chicago 6, Ill.

Circle 42 on Reader Service Card

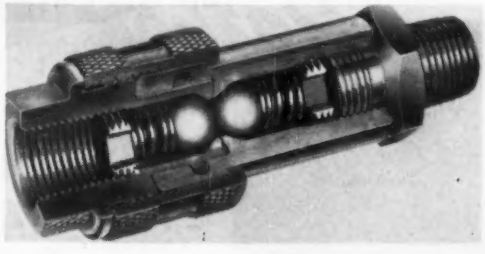
application and performance of NEW COMPONENTS

LIMIT SWITCHES—Micro Switch, Division of Minneapolis-Honeywell Regulator Company, has added two new actuators to their Type ML line of heavy duty precision limit switches which are readily applied to the actuation of air and oil valves on machine tools. The original type ML switch has an adjustable roller arm actuator. The 2ML1 has a straight plunger actuator and the 5ML1 has a roller-plunger actuator. The roller-plunger actuator is adjustable 90 degrees in either direction to place the roller in line with the actuating force. The 1ML1 has an operating force of 2 pounds maximum, and a release force of ¼ pound minimum. The 2ML1 and 5ML1 have operating forces of approximately 6 pounds and release forces of 4 pounds.

Micro Switch Division

Circle 101 on Reader Service Card

HIGH PRESSURE HYDRAULIC QUICK COUPLER—Two very tough problems have been overcome by the Pioneer Pump Mfg. Co. with their new No. 3000 Hi-Pressure coupler now in production. They are: the ability to hold extremely high pressures and still have very little



pressure drop. This quick coupler is only 3½ in. long with an o.d. of 1⅜ in and is guaranteed to withstand a burst pressure of thirty thousand psi. Reliable pressure drop tests show that at a flow of five gpm there was no appreciable rise on a 1000 psi gauge. This coupler can be coupled and will swivel at low pressures without the loss of any oil. Available in a ⅜ in size only, it has a ⅜ male fitting on one end and a ⅜ in female on the other. It comes complete with a dust cap to insure a clean hydraulic system at all times. This coupler is recommended for any hydraulic application using operating pressures up to 10,000 psi.

Pioneer Pump Mfg. Co.

Circle 102 on Reader Service Card

HIGH PRESSURE PUMP—A rugged, compact high pressure triplex pump has recently been introduced by Kobe Inc. Division of Dresser Equipment Co., as a heavy-duty packaged hydraulic power generator for all types of hydraulic power systems. The unit is available in 15 hp sizes with pressure ratings up to 5,000 psi and displacement ratings up to 60 gpm. Special 10,000 psi and 20,000 psi heads are available. Features of the Kobe Triplex pump include integral gears, available in a wide variety of ratios. The unit can be obtained with an integral, drip-proof electric motor drive which greatly simplifies installation problems common to this type of pump. Plungers and liners are interchangeable, which provides a variety of pressure-volume ratings for each unit. Spring loaded balls and hardened-and-ground seats serve as inlet and outlet valves. Pressure lubrication is one of several built-in features which also include pressure gauge, relief valve, and scavenger pump. The Kobe Triplex is completely enclosed.

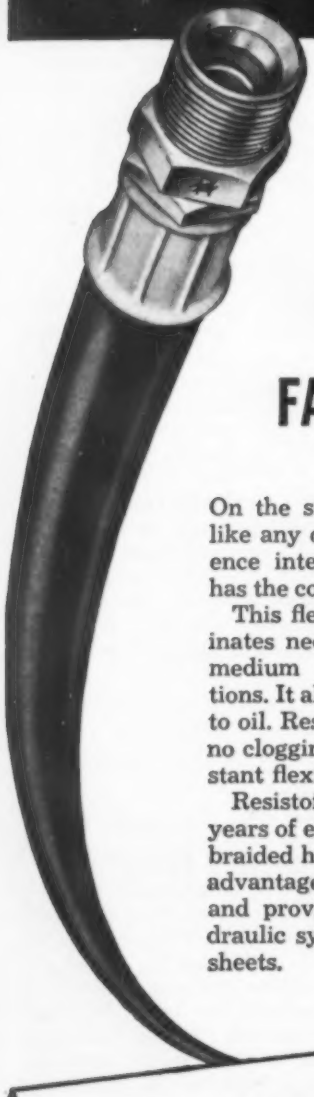
Kobe Inc.

Circle 103 on Reader Service Card

RUBBER IMPREGNATED LEATHER PACKING—Announcement of a brand-new type of rubber-impregnated leather packing, culminating four years of research and field test is made by E. F. Houghton & Co. This new packing, to be known as the No. 1243 VIM leather packing, offers distinct advantages over either synthetic rubber or wax-impregnated leather. It combines the lower friction and greater strength of leather with the perfect sealing, resilience and heat resistancy of rubber. Its advantages may be summarized as follows: 1) improved sealing ability, because of the high resiliency factor; 2) Ease of assembling, because of the springiness rubber provides; 3) Exceptional resistance to oils and solvents; 4) Resistance to heat as high as 200 F; 5) Resistance to plastic flow, or extrusion; 6) Low friction characteristics; 7) High abrasion resistance; 8) Long life because of the reinforced fiber structure and the remarkable sealing qualities of the impregnant.

E. F. Houghton & Co.

Circle 104 on Reader Service Card



...and you'll see why it's

OILPROOF!

FATIGUE-PROOF!

On the surface, Resistoflex hose looks like any other hose. But what a difference internally. Only Resistoflex hose has the compar tube.

This flexible, high tensile tube eliminates need for metal reinforcement in medium pressure hydraulic applications. It also makes the hose *impervious* to oil. Result: No erosion, no gumming, no clogging. And no fatigue under constant flexing conditions.

Resistoflex has proved skill and long years of experience in the fabrication of braided hose with synthetic tubes. Take advantage of the quality this assures and provide trouble-free, cleaner hydraulic systems. Write for specification sheets.

For out of the ordinary engineering with synthetics

RESISTOFLEX

RESISTOFLEX

CORPORATION

Belleville 9, New Jersey

Circle 43 on Reader Service Card

VANE TYPE ROTARY PUMP—A heavy duty, vane type rotary pump has been added to the existing line of rotary pumps manufactured by Worthington Pump and Machinery Corporation. All models are positive displacement, sliding vane type in which the pressure of the liquid being pumped maintains contact of the vanes against the liner. The pumps are to be manufactured in both internal and external bearing design; the external bearing models being especially suited for non-lubricating liquids. The pumps are manufactured with built-in relief valve and can be manufactured in either standard fitted, bronze fitted or in all bronze construction.

Worthington Pump and Machinery Corporation

Circle 105 on Reader Service Card

PRESSURE SWITCH—Tests on Meletron pressure switches with a new diaphragm configuration demonstrate that this new pressure actuated switch is more resistant to the high frequency vibration found in most present day aircraft and rocket engine applications. The tests showed that response characteristics are consistent over a larger pressure range than ever before. The new design has made possible a lighter, smaller unit which is also available with 100 percent stainless steel pressure sensing element for use with most corrosive liquids and gases.

Meletron Corporation

Circle 106 on Reader Service Card

HYDRAULIC VALVES

Pathon

HYDRAULIC CYLINDERS

• WRITE today for literature covering Pathon's new Solenoid Controlled Pilot Operated Hydraulic Valves, Bulletin No. 15 and/or Hydraulic Cylinders, Bulletin No. 17.

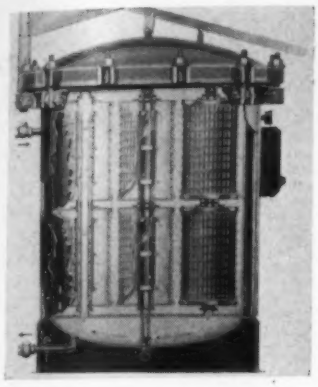
PATHON MFG. CO.

1733 CENTRAL AVENUE

CINCINNATI 14, OHIO

Circle 50 on Reader Service Card

OIL FILTERS—The Hilliard Corporation has brought out an improved line of lubricating, fuel and industrial oil filters, including swing-bolt head construction for quick opening of filter covers and a lifting device for ease of handling. They are available using both factory-made filter cartridges and the repackable type which the operator repacks from a bulk supply of filtering material. Units are available in capacities ranging from ½ gpm up to 1000 gpm for bypass filtering, and in stationary or portable types.



Hilliard Corporation

Circle 107 on Reader Service Card

SLIP RING ELECTRIC MOTOR—Slip ring motors have wide usage where variable speed or high starting torque on low strating current is required. Compactness and mounting adaptability are important factors and are very apparent in a new design just announced by the Reuland Electric Company. Other important features include: shorter bearing-to-bearing spacing; superior wound rotor construction, and larger inspection openings.

Reuland Electric Company

Circle 108 on Reader Service Card

Circle 47 on Reader Service Card

"SEAL-GUARD"
METALLIC ROD WIPER

PROTECTS YOUR CYLINDER RODS, MACHINE SPINDLES, GUIDE PINS AND LOCATING PINS

The "Seal-Guard" Metallic Rod Wiper affords permanent protection from falling or flying debris . . . Two flexible bronze rings mounted in synthetic rubber lift off harmful substances completely by means of their knife-edged conical surfaces . . . The device is self-adjusting through action of rubber on staggered scraper rings . . . Rod diameter sizes are from ½ to 10 inches.

Write for Literature

HYDRAULIC ACCESSORIES CO.
439 E. Fort St. • Detroit 26, Mich.

QUALITY — A CARDWELL TRADITION SINCE 1829

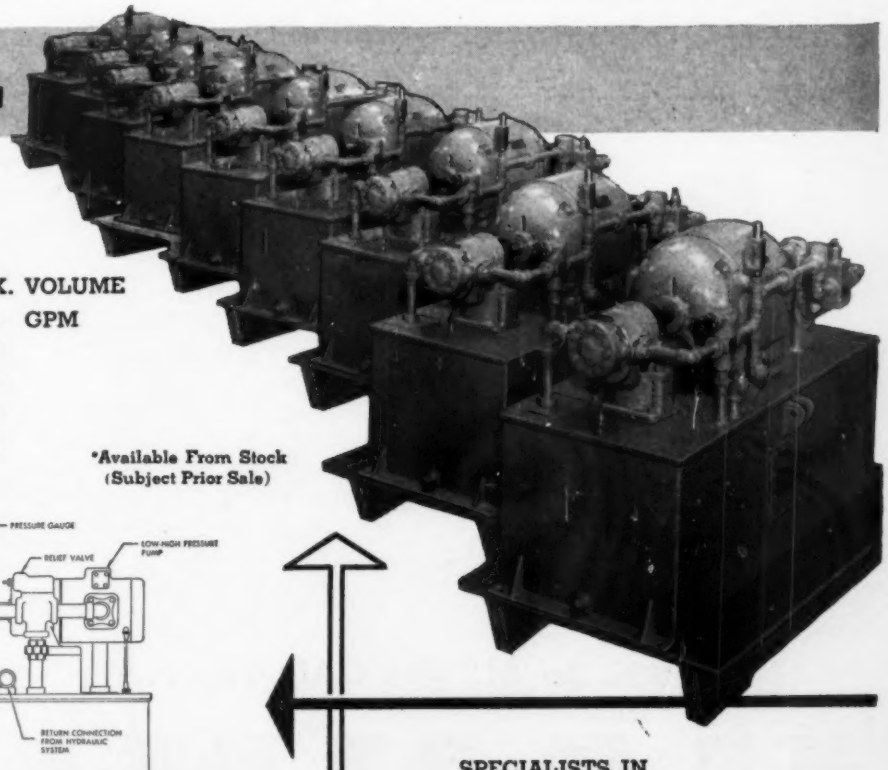
CARDWELL

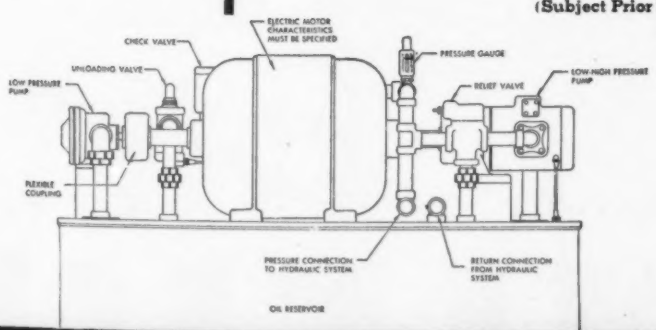
SRD ROTARY HYDRAULIC POWER UNITS

PRESSURES UP TO 2000 PSI

MODEL	MAX. VOLUME
SRD 1 -	12.2 GPM
*2 -	17.8
3 -	28.3
4 -	41.9
*5 -	51.8

*Available From Stock (Subject Prior Sale)

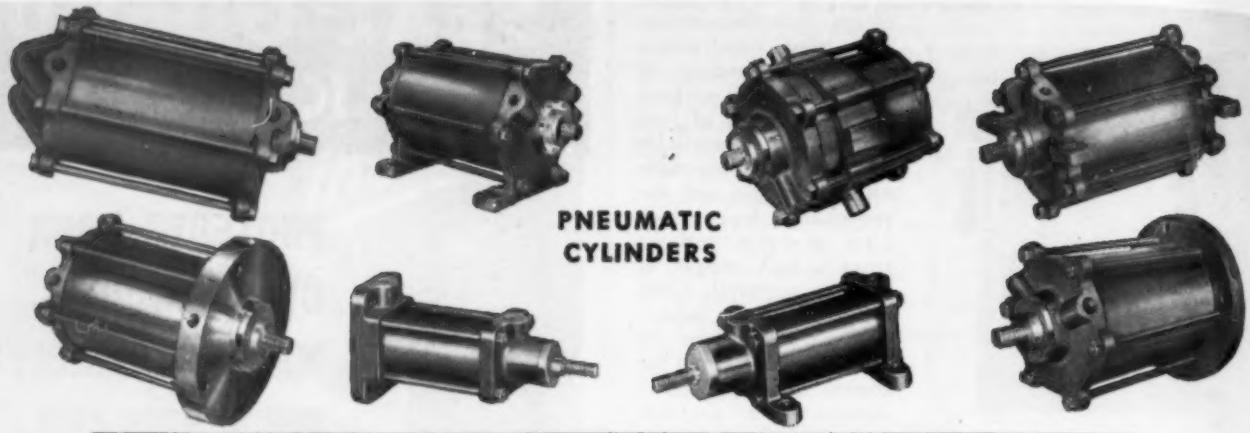




SPECIALISTS IN CUSTOM BUILT HYDRAULIC POWER UNITS

The CARDWELL MACHINE COMPANY
Franklin at 19th St. • Richmond 11, Virginia • Phone: 7-2985

Circle 51 on Reader Service Card



PNEUMATIC CYLINDERS

Q: Joe, do you think you can buy a cylinder to do this job? It looks plenty special to me!

A: Absolutely, Boss! Hannifin has more than 65 different mounting combinations in hydraulic cylinders, alone. And, if it has to be a special cylinder, Hannifin can build that, too.

Hannifin is *the* authoritative source for the broadest range of hydraulic and pneumatic cylinders—backed by an experienced corps of engineers, sold by a large force of factory-trained field engineers. Illustrated here are only a few of the many standard Hannifin hydraulic and air cylinders. Hannifin Corporation, 1155 South Kilbourn Avenue, Chicago 24, Illinois.

Complete hydraulic cylinder catalog, illustrating design features, styles, dimensions. Also bore tables, engineering data and formulae.

Complete illustrated pneumatic cylinder catalog giving design and construction features, bore tables, mounting styles and other information.

HYDRAULIC CYLINDERS

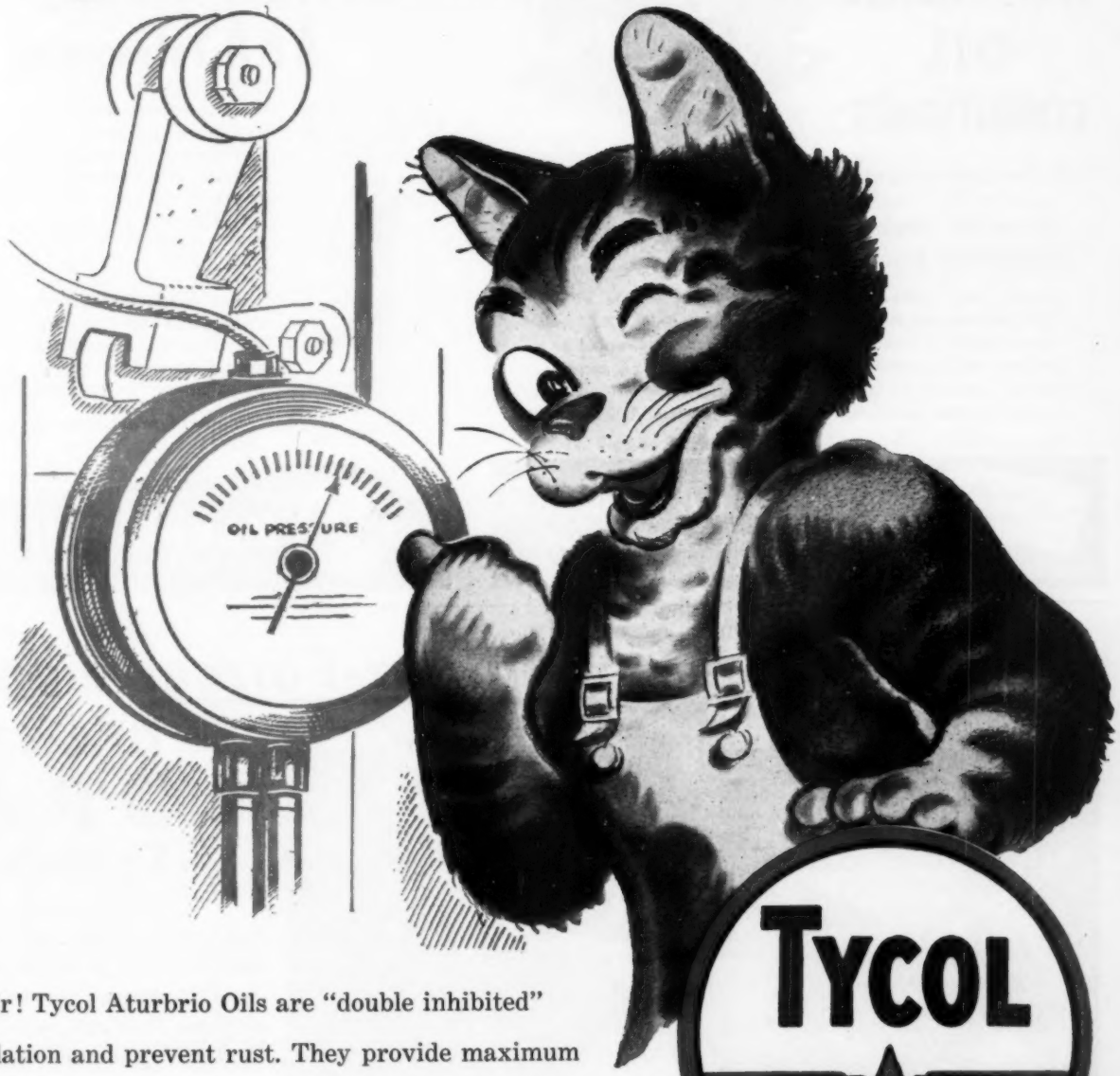
YOU CAN BE *SURE*, IF YOU—do *ALL* you CAN do... with

HANNIFIN

Air and Hydraulic Cylinders • Hydraulic Power Units • Pneumatic and Hydraulic Presses • Hydraulic Riveters • Air Control Valves

Circle 49 on Reader Service Card

"Tycol Aturbrio remains stable... gives full protection against system moisture corrosion"



Yes, sir! Tycol Aturbrio Oils are "double inhibited" to resist oxidation and prevent rust. They provide maximum resistance to emulsification . . . permit continuous operation with minimum wear. They have reduced hydraulic system operating costs in hundreds of plants . . . performing superbly and assuring minimum wear of moving parts.

Complete information is available from your nearest Tide Water Associated office. Call or write today.

TYCOL

INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C. • Pittsburgh
Philadelphia • Chicago • Detroit
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TIDE WATER ASSOCIATED OIL COMPANY

17 BATTERY PLACE · NEW YORK 4, N. Y.

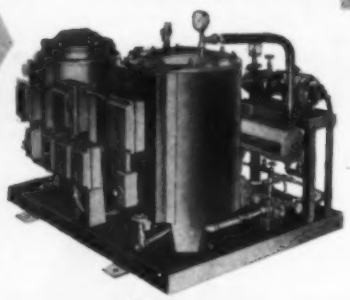
SEND FOR A FREE COPY OF "TIDE WATER ASSOCIATED LUBRICANIA"

Circle 201 on Reader Service Card

Circle 52 on Reader Service Card

Restores used hydraulic oil to like-new condition

HOFFMAN OIL CONDITIONER



Removes soluble and insoluble impurities
Capacities from 25 to 600 g.p.h.

Protects your hydraulic equipment—lengthens oil life without high maintenance cost of centrifuges. The Hoffman Oil Conditioner consists of a cartridge filter and vaporizer, mounted on a common base, portable if desired. Complete with all necessary electric and pump connections. Only two moving parts—no steam or water connections. Write for technical bulletins.

FILTRATION DIVISION
U.S. HOFFMAN MACHINERY CORPORATION
218 LAMSON STREET, SYRACUSE 6, N. Y.
CANADIAN PLANT: CANADIAN HOFFMAN MACHINERY CO., LTD., NEWMARKET, ONT.

Circle 79 on Reader Service Card

PROTECTED against abrasion

A&A Telescoping sleeves

Protect moving parts while overcoming the weaknesses of leather sleeves. New A & A telescoping sleeves are designed to prevent mechanical breakdown of hydraulic equipment operating in dirty conditions. Here's anti-abrasive protection you need for exposed piston rods, rams, boosters and shifting devices for valves — Made of Gortite, a high tensile strength neoprene impregnated material, to withstand tmperature changes of -60 Deg. F to 180 Deg. F without cracking — Supplied for angular, horizontal or vertical service in standard sizes or in sizes to fit your specific requirements.

Get complete details, write today for bulletin AH 1.

A&A MANUFACTURING CO.
2017 W. Clybourn St. • Milwaukee 3, Wisc.

50-TON Contour-Former employs GIANT NOPAK Cylinder

Built by the Cyril Bath Co., Cleveland O., this powerful machine is used to shape curved aluminum airplane fuselage parts. A NOPAK Model "A" 10" x 80" Hydraulic Cylinder . . . operating at 1500 P.S.I. . . . works in conjunction with the forming die, mounted on a gear-driven turntable, to stretch-form an infinite number of curved structurals . . . with 700 different dies now in use.

Very likely the efficiency of machines you build or use can be stepped up substantially through the correct use of NOPAK Valves and Cylinders.

GALLAND-HENNING MFG. CO.
2743 S. 31st St., Milwaukee 46, Wisconsin

Representatives in Principal Cities
•
Refer to Sweet's File for Product Designers or write for Bulletin SW-1

NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

A 5984-½H-AA

Circle 53 on Reader Service Card

Useful Catalogs and Bulletins

available for reference

Master and Slave Units . . . The new line of Sperry Hydraulic Remote Controls is described in Bulletin 20-106 released by Sperry Products, Inc. These controls are the only single tube, balanced, self-contained system operating independently without outside sources of power. They are now being used for manual, or automatic control of many varied devices in the industrial, automotive, aviation, railroad and marine industries. Quick, easy installations are assured with the use of a single copper tube which therefore eliminates usual maintenance problems. The Sperry Controls have a maximum rated capacity of 400 in lbs on the pressure stroke and 125 in lbs on the return stroke.

Circle 120 on Reader Service Card

Hydraulic Hose Assemblies . . . This eight page Bulletin prepared by Mulconroy Company gives design and application data on their hose assemblies for pressures from 250 psi to 5000 psi. The new construction of the "Press-Lock" couplings is illustrated. Hose construction for various services is shown along with installation data.

Circle 121 on Reader Service Card

Check Valves for Air and Oil . . . The distinctive, simple Circle Seal principle for providing positive leakproof sealing at high and low pressures, is described in a three color bulletin available from James-Pond-Clark. Both aircraft and industrial check valves are offered in a high and low pressure series. Dimensional data is provided along with technical characteristics which include working pressures and temperatures, fluids handled, leakage and pressure differentials.

Circle 122 on Reader Service Card

Solenoids . . . One of the most important uses of solenoids is for the actuation of air and hydraulic valves. The G-600 line, specifically designed for fluid power applications, is described along with 11 other standard lines in an 8 page Bulletin offered by Trombetta Solenoid Corp. Size, stroke and dimensional data is charted. A page of solenoid fundamentals is included to familiarize the user with the basic advantages and limitations of solenoids.

Circle 123 on Reader Service Card

Hydraulic Cylinders . . . New Catalog Section No. 105, published by Rivett Lathe & Grinder, Inc. describes 108 different models of hydraulic cylinders, each in ten bore diameters. The three color book lists every standard hydraulic cylinder offered in the industry. Working drawings and specifications are furnished for each model and size cylinder, both standard and cushioned types, standard rod and 2:1 over-size rod, single and double end rods, internal and external threads. All information relative to a particular model is shown on one page, facilitating easier layout of circuits by the engineer. Cylinder mountings described are rabett, foot, trunnion, center line, blind end flange, rod end flange, and clevis, in 2 in to 10 in bore diameters, with strokes up to 96 in. Rivett standard hydraulic cylinders are recommended for pressures of 1500 psi maximum and special cylinders are available for pressures to 3000 psi and higher. Water cylinders are likewise listed in pressure ranges to 300 psi, 1500 psi and 3000 psi.

Circle 124 on Reader Service Card

Pressure Gauge Protector . . . A gauge snubber or shut off which automatically protects your pressure gauges from shock loads is an important part of circuit design. Sprague Engineering and Sales offers a catalog sheet giving construction and operation data on their gauge shut offs. The shut off is designed for positive protection against overloads to gauges, its positive opening and closing action eliminates the need for a relief valve and manually operated gauge shut off valves. Models are available for pressures to 5000 psi.

Circle 125 on Reader Service Card

High Pressure Reciprocating Pumps . . . Designed for industrial applications including central hydraulic systems, four types of John Bean reciprocating plunger pumps are detailed in a 28 page illustrated catalog. Specifications, dimensional layout, cutaway views and typical installations are included for triplex inside packed, triplex outside packed, multiplex power ends and duplex inside packed pumps. Triplex outside packed pumps are designed for capacities of 1 to 7.5 gpm for operating pressures of 6000 psi. The final section of the catalog describes pump accessories: pressure regulators, relief valves, air chambers, pressure gauges and gate valves.

Circle 126 on Reader Service Card

Silicone "0" Rings . . . Silicone rubber "0" rings molded by Frederick S. Bacon Laboratories are the subject of Technical Data Sheet No. 102. These "O" rings are made in special dies which allow for the higher shrinkage factor encountered with silicone rubber and thus may be depended upon to have the dimensions specified. They provide hydraulic seals resistant to petroleum oils and most hydrocarbons. They are claimed to display outstanding efficiency at either high or low temperatures, the rubber stock being more resistant to deformation under compression than either natural or other synthetic rubbers and retaining flexibility even at temperatures of -65 F and lower.

Circle 127 on Reader Service Card

HIGHER EFFICIENCY

with light aircraft oils or heavy industrial oils

DENISON HydrOILics

High-Pressure, High-Volume PUMPS for All Circuit Needs to 5000 psi

Here's high-pressure, high-volume efficiency on a wide range of ruggedly built pumps. They feature complete hydraulic balance that eliminates the use of thrust bearings . . . simplified construction that requires fewer parts . . . exclusive axial piston design that assures longer, maintenance-free service, *and many other advantages.*

Denison HydrOILic Pumps include constant-volume and variable-volume types for all circuit requirements up to 5000 psi, with volume delivery capacities ranging from 2 to 35 gpm. Variable-volume types are available with stem, handwheel, or compensator control. A choice of face, flange or foot mountings is offered on all of these pumps.

Increasing demands for modern high-pressure systems, and the resulting need for compact hydraulic units built to withstand long, hard high-pressure operation, have led to the wide preference for Denison Pumps.

The tougher the job, the quicker you discover the advantages of Denison HydrOILic Pumps, developed through 25 years of experience in designing and building oil-hydraulic equipment *exclusively.* Put these advantages to work in your hydraulic circuits — for either intermittent or continuous service.

Write today for full details on pumps to fit your needs.

The DENISON Engineering Co., 1166 Dublin Rd., Columbus 16, Ohio

DENISON PUMPS

Circle 54 on Reader Service Card

Pumps and Valves . . . Gre-Sen Manufacturing Company has prepared a booklet of data sheets describing their gear pumps for hydraulic systems and manually controlled 3-and 4-way directional valves. Widely used on many agricultural applications, these components can readily be applied to industrial power applications. The pump has a maximum pressure rating of 1000 psi, delivering 12 gpm at 400 rpm. Maximum operating speed is 800 rpm.

Circle 128 on Reader Service Card

Asbestos Fabric Packings . . . The complete line of R/M asbestos fabric packings is illustrated and described in a new bulletin just issued by the packing Division, Raybestos-Manhattan, Inc. Also included in the bulletin are complete service recommendations, sizes available, standard packages, and packaging specifications.

Circle 129 on Reader Service Card

Rotary Vane Type Air Compressors . . . In four page Bulletin C-6, Fuller presents application and construction data on their line of rotary compressors. Cross-section drawings show the principle of operation. The eccentrically mounted, accurately machined rotor, with integral shaft, is supported on roller bearings in each of the heads. The vanes slide freely in milled slots in the rotor, and are held pressure tight against the cylinder by centrifugal force. Details of the intake regulator and end bearings are given.

Circle 130 on Reader Service Card

Hydraulic Cylinders . . . The Ortman Miller Machine Co., Inc. has issued a new 28 page catalog on O-M air, hydraulic and water cylinders. This fully diagrammed catalog, bound in a durable two color cover, contains complete engineering specifications, data on O-M's special internal locking system and full listing of O-M parts. Data shown covers standard, oversize and 2:1 piston rods.

Circle 131 on Reader Service Card

Corrosion of Copper Alloys . . . For twenty-five years, The American Brass Company's technical staff has conducted continuous laboratory research and field study of the nature of corrosive attack on copper and copper alloys. The results of these studies have been published now in a 24-page booklet, "Corrosion Re-

sistance of Copper and Copper Alloys". This publication, first of its type in the industry, explains the chemical and physical nature of corrosive attack in its various forms. Included is a tabulation indicating the relative corrosion resistance of the principal types of copper and copper base alloys when in contact with 183 different corroding agents.

Circle 132 on Reader Service Card

Tube Fittings . . . Double and single nut tube fittings, manufactured by Logansport Machine Co., Inc., are described in a 44 page Catalog. The "Collet Grip" fitting permits the use of tubing having a wide range of wall thicknesses. The fitting is designed to place the heavy load on the tube and fittings where it can be safely carried and not on the flare. Complete dimensional data is charted with easy-to-read line drawings. The single nut series is designed for close work.

Circle 133 on Reader Service Card

Hose Clamps . . . Dimensional data for their line of hose clamps is contained in a four page bulletin available from The Hansen Manufacturing Company. Construction of the reusable compression type clamps is described. Each hose clamp consists of two parts, a stem and a ferrule. The stem has either a male or a female pipe thread on one end, and at the other a tapered stem to fit the inside diameter of the hose. The ferrule acts as a collar, against which the hose is compressed when the assembly is made.

Circle 134 on Reader Service Card

Electric Motors . . . Catalog sheets describe the Sterling Klosd-Tite electric motors. These motors feature heavy-duty ball bearing construction, interchangeable voltage, ample connection space, vinol-acetal-insulated wire stator windings, special stator coil and insulation treatment and permanently welded stator coil connections. These general purpose motors are well suited for hydraulic pump drives where one constant normal speed is required.

Circle 135 on Reader Service Card

Paint-anchoring . . . A new booklet describing Anchorite 100, a paint-anchoring corrosion-resistant phosphate treatment for metals, has just been published by Octagon Process, Inc. The booklet describes the common causes of paint failure and how they can be prevented. It then goes into methods of application—immersion of and spraying—of the Anchorite 100 treatment.

Circle 136 on Reader Service Card

PACKAGED POWER

in pressure capacities from 400 to 5000 psi

DENISON HydrOILics

Pumping Units for Highest Efficiency on Every Type of Circuit

You get extra ruggedness and efficiency *plus lowest operating costs* when you select Denison HydrOILic Pumping Units. Built in 37 different models, they meet any circuit need that calls for a pressure capacity of from 400 to 5000 psi . . . for constant or variable volume operation . . . with volume control by hand wheel, stem or pressure compensation . . . volume deliveries from two to 35 gpm. Capacities of the oil reservoirs range from 16 to 165 gallons.

One of the big reasons for the fine performance records of these high-pressure, high-volume pumping units is that they are built around the famous HydrOILic axial piston pumps, described on the opposite page. These hydraulically balanced pumps have shown exceptionally high volumetric efficiencies in repeated tests made at operating pressures up to 5000 psi.

Single-panel mounting of motor, pump, relief valve, gauges and controls permits quick, easy, low cost maintenance — and adds to compact assembly that simplifies circuit arrangements. All larger series units are of horizontal design, and meet JIC standards.

You get the benefits of *proved performance* backed by 25 years of specialized experience in building oil-hydraulic equipment, when you power your circuits with Denison HydrOILic Pumping Units! Write for further information.

The DENISON Engineering Co., 1166 Dublin Rd., Columbus 16, Ohio

DENISON PUMPING UNITS

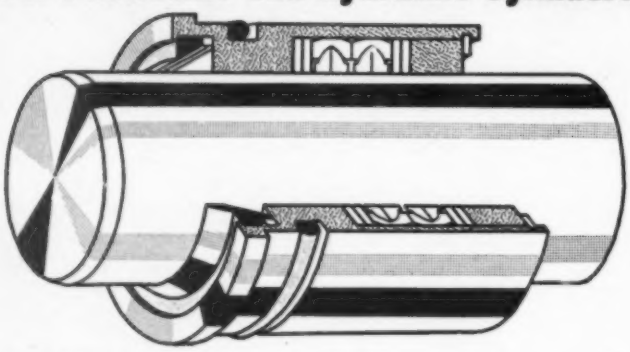
Circle 55 on Reader Service Card

Circle 56 on Reader Service Card

SPECIFY the NEW

MONOPAK-CARTRIDGE PACKING UNIT!

For Pneumatic and Hydraulic Cylinders



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With air the most expensive pressure medium today, these 4 leak-proofing features of Nicholson air traps are proving important cost-cutters:

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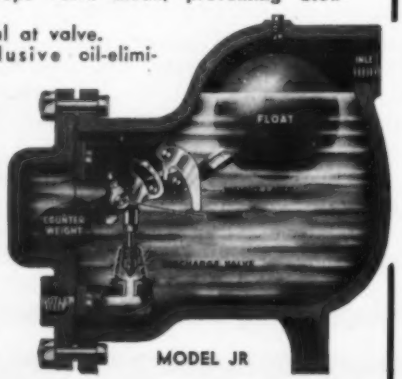

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TRAPS · VALVES · FLOATS

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Conference Papers

Continued from page 38

5.) careful arrangement of oil passages with a flow director to eliminate turbulence of joining oil streams to facilitate filling of the pump inlet port.

6.) a special pulse filter consisting of a section of 3/8 inch inside diameter hose with high volumetric expansion connected in series with a section of conventional high pressure 1/4 inch in diameter hose,

7.) isolation of the steering column and jacket from the passenger compartment.

Steering gear noises were hiss and valve clatter. The

W. A. Hunter is project engineer, Engineering Division, Chrysler Corporation, Detroit, Mich.

Growth and Application of the Accumulator

By Edward M. Greer

Accumulators provide a simple means of storing pressure and compensating for system leakage; they may be used as a fluid dispenser, as transfer barrier or as a shock absorber.

THE first part of the paper covers growth and development of the various types of accumulators now in use in the hydraulic industry. The second part of the paper covers the various types of application of the accumulator to hydraulic systems.

The hydraulic accumulator is defined as a means of storing hydraulic power as well as absorbing hydraulic pulsations and shocks.

The history of the hydraulic accumulator is taken back to ancient times where it was used to overbalance loads on a lever by the gradual filling of water into a tank. From here it is traced to application on presses, then to its development in the aircraft industry and through the growth of its use on machine tools, road building machinery and the regulation of pressure and flow in modern hydraulic systems.

The various types of accumulators are discussed, giving the principles of their design. These are divided into three types: Weight loaded, Spring loaded, and Pneumatic, and these subdivided into non-separator and separator types. In the non-separator type, the pump surge chamber or air bell is shown, and a large air bottle type installation as well as the design of an air bottle type accumulator are shown. In the separator type of hydro-pneu-

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CYCLING TO 600 PER MIN.

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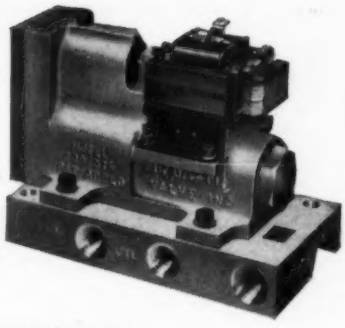

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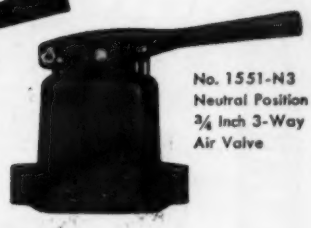

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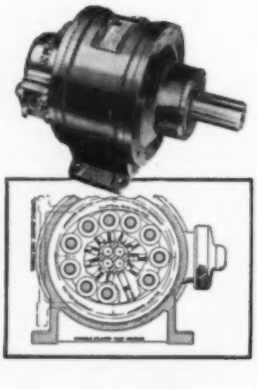

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matic accumulator, the piston and the flexible separator types are shown and described. The simplest piston type accumulator, resembling a hydraulic actuator, and the floating piston type accumulator are shown and described. The differential piston or gas ballast type is also shown and described. Various types of flexible separator accumulator, such as bellows separator, tubular rubber, flexible diaphragm type and spherical type are shown. The conical bag type accumulator as developed by Greer is shown and described and the principle of convolutions is illustrated.

Edward M. Greer is president, Greer Hydraulics, Inc., Brooklyn, N. Y.

Practical Evaluation of Filters

By Arthur McHugh

An understanding of the basic types of filters their construction, and the impurities which they will remove is important to the user of hydraulically powered machines. Efficient, continuous operation is dependent upon maintaining oil in working condition.

THE general problem is to keep machine tools operating safely, with uninterrupted production and long life. A major factor involved is keeping the hydraulic system clean and free of contaminents. The equipment designed to do this job is the hydraulic filter.

Filters for hydraulic oil are generally classified as follows:

1. Mechanical type
2. Adsorptive type

(1) Mechanical filters are of the edge filtration type or the cartridge type. The screen type, according to J.I.C. Standards, is classified as a strainer and will not be discussed in this paper. The cartridge, for the cartridge type filter, is usually made of waste or some other fiberous material surrounded by a suitable cover, such as wood pulp, then inserted in a cloth bag or metal container. Another type of cartridge is made of pleated paper.

(2) Adsorptive filters are usually of the cartridge type. The filtering media is usually fullers earth or activated alumina. The cartridge is usually made with an earth core surrounded by a wood pulp or cloth cover, then inserted in a cloth bag or metal container. The advantage of this type of filter is that it will adsorb acids, that are formed as a result of oxidation, as well as particles of grit, dust and abrasives.

Tests in the field show that the cartridge type oil filter mounted on the machine will maintain the quality of the oil much better than complete oil changes made periodically.

The results of field and laboratory tests show that the adsorptive type filter installed on each machine tool is the best oil conditioning method.

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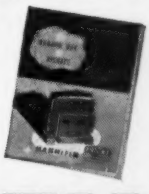
Quiet . . . dependable . . . economical. Unlimited range of applications. Ideal for remote control or for building into equipment. Two types. Ask for Hannifin recommendations.



GET BULLETIN 230

Contains specifications, dimension table, wiring diagrams and other useful data.

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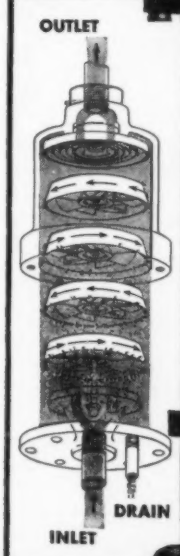
CLEAN YOUR AIR AND GAS LINES

Removes 92% Oil, Water and Dirt



The Aridifier gives you positive removal of oil, moisture and other foreign matter from air or gas lines. With paints and lacquers it often eliminates bloom and imperfections in finish. It provides dry lines for ceramics, sand blasting, for air cleaning, etc. Wherever the need exists for *dry* clean air or gas, the Aridifier delivers the goods. Easily installed. No maintenance problem. 10 models available. Capacity range: As low as 7 CFM to 17,000 CFM.

BULLETIN 147 Tells The Complete Story

HOW IT WORKS **Exploded view shows how four multi blade rotors revolve at high speed in opposite directions under impact of air movement through non-aligned rotor spaces. Moisture, dirt and other foreign matter which collect on rotor blades are thrown out of air stream by centrifugal force to side of housing, and pass into drain.**

Made By The Manufacturers of Logan Lathes and Shapers.

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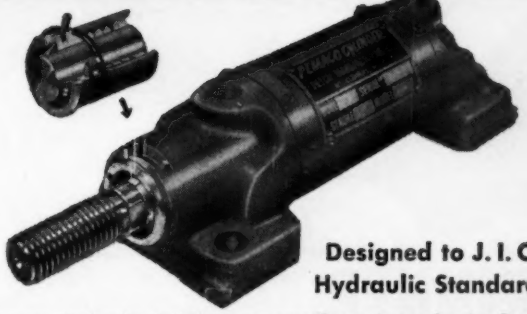
PEMACO HYDRAULIC AND AIR CYLINDERS with the NEW Cartridge Type Packing Gland



Designed to J. I. C. Hydraulic Standards

Pemaco Hydraulic Cylinders are soundly engineered—give long life and top performance. The steel ram is hardened to 50.C Rockwell, ground and lapped. NOW the Pemaco has the first self-contained Cartridge Type Packing Gland.

This new Pemaco "EASY-PAK" Gland is designed to comply with J.I.C. Standards. It combines double bearing surface, low friction ram seal, and a ram wiper into a single compact unit. Easily maintained, the Pemaco "EASY-PAK" Cartridge Type Packing Gland can quickly be replaced in most cases without removing the cylinder from the machine — and by inexperienced help — greatly reducing machine down-time.

Pemaco "EASY-PAK" Cartridge Type Packing Glands are manufactured for both hydraulic and air cylinders.

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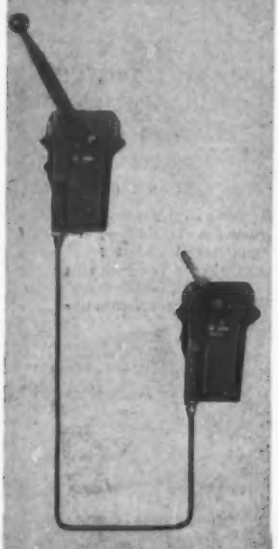

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EASY TO INSTALL

Single copper tube permits neat, compact installations. Maintenance is simple. No compensators—no pressure accumulators.

EASY TO OPERATE

Adaptable and versatile for single and multi-purpose control. Mounts convenient to operator.

ACCURATE — DEPENDABLE

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The small size of Skinner Solenoid Valves belies their rugged construction and unusually large capacity. These valves have a standard range from 5 to 250 p.s.i., and a special range from 5 to 850 p.s.i., and can be used for gaseous or liquid media. Their soft insert seat prevents leakage and positive action is assured by spring loading. Skinner Valves may be used in any position, with pipe connections furnished to suit specifications. Power consumption is 10 watts max. Special coils for high humidity or high temperature applications can be supplied. Standard models are approved by Underwriters' Laboratories.

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improving service to customer

COMPRESSED Air Products, manufacturers representatives with offices in Maplewood, New Jersey, New York City, and Amherst, Massachusetts, have joined the fast growing ranks of sales organizations using the airplane as a modern means of travel.

The accompanying photograph is of James H. (Jimmy) Stewart, hydraulic sales engineer for Compressed Air Products, with his four place Navion with which he covers his territory.

With cruising speed of 150 mph and a pay load

of 800 pounds, emergency delivery of heavy hydraulic and air equipment is but one of the services being rendered to industrial plants. Travel time is now measured in minutes instead of hours for most business calls.

In addition to the important savings of time, actual savings in travel costs have made air travel economically worth while in this area. Practically every industrial town in the sales territory has its own airport and modern facilities for air travelers.

Temperature Regulation

Continued from page 29

on a production boring machine. The heating element is electrical, thermal controlled, and the tube type cooler is controlled by a self contained modulating thermal valve. A word of caution: on most systems it is a good practice to interlock the electrical heater with the hydraulic pump motor to prevent charring of non-circulating oil.

Also in line with common production practice, assume that this machine was not always as shown in Figure 3. Assume that this machine, like many perhaps in your plant, had to be re-engineered for higher production. What happens? The high volume 8 gpm pump was replaced with a 10 gpm

pump; the 5 hp electric pump motor was replaced with a 7½ hp motor. Also, the reservoir capacity was not increased because it happened to be part of the machine column and there was no space to install a separate reservoir. And, in addition to the hydraulic system changes, automation was added for automatic loading and unloading of parts. Does this sound familiar?

The result is, that for a machine for which temperature regulation may have been desirable in the past, now becomes an absolute necessity to maintain a uniform production schedule with uniformly high quality parts.

Honest answers to the check points given at the beginning of the article will give you a clear picture of the advantages which adequate heat exchangers and automatic temperature regulating devices will give you in increased efficiency of your hydraulic circuits on production machines.

As you probably know, most components in a hydraulic system must have internal leakage to provide lubrication for their moving parts and sufficient clearance to function without sticking at a wide temperature range. It is important that the designer, buyer and process engineer and the maintenance supervisor consider this leakage factor. How much leakage can your application tolerate; more important, can this leakage vary?

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NO. 3A – Bore 1½", Shaft ½" Stroke 5", Length 10½" 5.75
NO. 9E – Bore 1-3/8", Shaft 1" Stroke 15-5/8", Length 15¾" 8.50
NO. 3S – Bore 1½", Shaft 1" Stroke 26", Length 23½" 15.75

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Self contained, 2 H.P. constant torque at all speeds with variable volume reversible, piston pump (controlled by outside lever.) supplying piston hydraulic motor. Automatic pressure, Dash pot for smooth control. Power output R.P.M. – 0 to 1/3 input R.P.M. in both directions. Input R.P.M. 1800 continuous 4000 intermittent. Dash pot can be removed for greater R.P.M. Ideal for Lathes, Duplicator Setup on Mills, Conveyors, Small Cars, Drives, Gearing, etc. Includes 2 - 4" Spline Shafts for input and power take-off. Cost Government approx. $400.00 32.50

AN-Hi-Press. HOSE (FUEL – OIL & AIR)
1/4" Tube Size – 7/16 x 20 Thread – 16" long with Male and Female fitting at either end. . .95¢ each.
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3/8" Tube Size – 9/16 x 18 Thread – 20" long with Female fitting at both ends. . . . . $1.90 each
Same as above but 63" long. . . . . $3.75 each
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5/8" Tube Size – 7/8 x 14 Thread – 15" long with Female fittings at both ends. . . . . $2.25 each.
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ANGLE PUMP Positive displacement type, angle piston. Displaces .507 cu.in. per revolution. Has capacity of 6 gal. per minute at 3000 RPM at 1500 PSI continuous 1875 for 15 seconds. Operating speed of 3750 RPM, intermittent maximum 4500 RPM. Rotates to the right only. . . . . NEW 17.50

P-3 STRATO POWER PUMP With built-in variable flow control valve in head. Positive displacement piston type. Displaces .450 cu. in. per revolution. Two gal. per minute capacity at 1500 RPM at 1250 PSI. Pressure limit, 1250 PSI continuous. 1400 PSI for 15 seconds. Operates at 3750 RPM, intermittent max. 4500 RPM. Rotation either direction without adjustments. NEW 17.50

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V-17 Poppet type. Pressure balanced. Off at-neutral position. Piston type with built-in relief valves for limit of cylinder strokes. Has 5/8" AN tube size (7/8"–14 thread) inlet and outlet. Ports to the cylinder are 1/2" AN tube size with 3/4"–16 thread. Many more in stock. Send for list. 9.75

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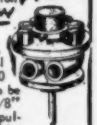
Logan Gerotor type. For operating hyd. systems on tractors, trucks industrial machinery, etc. Delivers 8 GPM, at 1200 RPM, at 1000 PSI with 5 HP. Can also be used as Hydraulic Fluid Motor. Has 3/8" stnd, pipe ports, ½" splined shaft for pulley or direct attachment. 5½" dia. x 7" lg. Used but guaranteed condition. Now ONLY 19.50

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in machine tools (taps, drills, dies, reamers, etc.). Hydraulic Cylinders, Valves, Pumps & Motors. Air Tools & Bearings.

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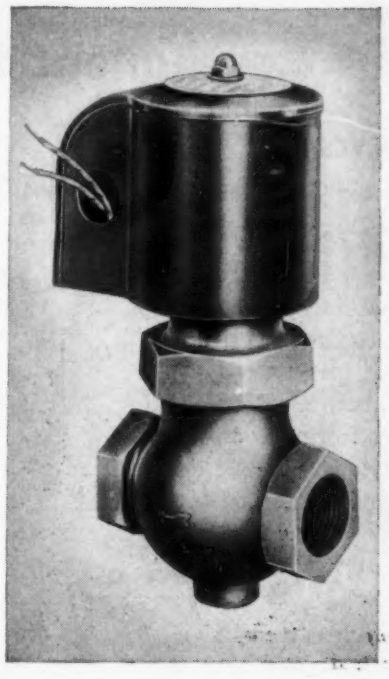
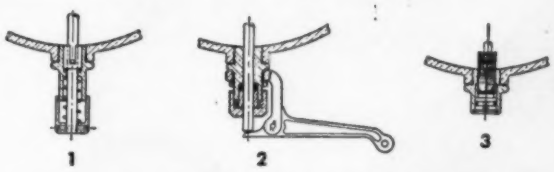


Bulletin 8210

General Purpose Control Valves

★ Full Port Area—Packless
★ For Air, Gas, Water, Brine, Freon, Methyl Chloride, Light Oil and other Liquids and Gases up to 212°F; Pressures up to 400 pounds
★ Several Auxiliary Variations
★ Several Sizes: ½ to 2½ inches

Our Bulletin 8210 Solenoid Valves are designed for those shut-off requirements where a simple, rugged, automatic control will serve. They close instantly when current to the coil is cut off. Full line pressure on top of the valve piston aided by a powerful spring assures tight closing. They reopen fully when the coil energy is restored. Only minimum current is required because the solenoid, when energized, is required to open only the small pilot port against the line pressure. The construction is such that the valve is held open by the solenoid for full pipe area independent of the flow through the pipe line.


1 2 3

Three auxiliary variables are available: (1) device for locking the valve in open position; (2) device for utilizing the valve for whistle control; (3) by-pass adjustment for holding the valve open.

Bulletin 8211 Valves are similar except that they have Explosion-Proof Solenoids approved by Underwriters' Inc., Class 1, Group D, Hazardous Location.

If you have any automatic control problems that fit into the above class, you might study fully the merits of Asco Bulletin 8210 and 8211 Solenoid Valves. Write us anyway, regardless of your problems, because we have many other types of solenoid valves.

ASCO Solenoid VALVES

When in need of Electromagnetic Controls, come to us.

Automatic Switch Co.
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Standards File Sheet

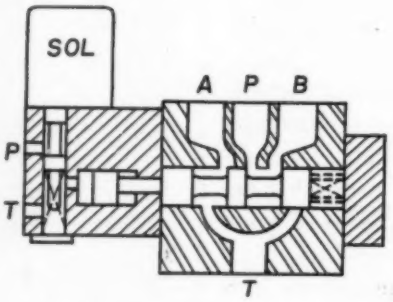
Know Your Component Symbols

DIRECTIONAL VALVES

Pilot Operated, Solenoid Controlled Hydraulic Series

MANY directional valves combine oil and electricity to position the valve spool. Large valves that would require costly, and awkward, large solenoids to power directly are most efficiently operated by having an optimum size solenoid to move a small spool which controls the flow of pressure oil to the large spool of the main valve.

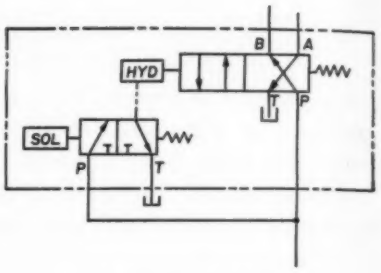
The schematic drawn here shows a single solenoid controlled, pilot operated 2 position, four-way valve. The J.I.C. symbol for this valve clearly indicates the operation. With the solenoid deenergized the springs acting against the main spool and pilot spool hold the valve in the shown position. Energizing the solenoid shifts its 2 position, three way valve to supply pressure oil to shift



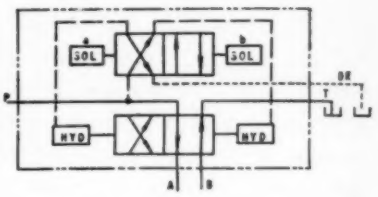
Schematic 2 position, 4-way valve

the main spool so that pressure oil will be directed to port A and return oil will go from port B to tank.

This solenoid controlled, pilot operated valve provides all the advantages of limit switch remote control operation inherent in the direct solenoid operated valves and makes use



J.I.C. Symbols for Pilot Operated, Solenoid Controlled Valves



Double Solenoid

THRUST PLATES
BEARING PLATES
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CONNECTING RODS
BUSHINGS
SEALS
A MONEY-BACK GUARANTEE OF LONGER SERVICE
PROMET
THE Engineered BRONZE
Machined or rough cast and of the specific formula best suited to the application.
Send blueprints, conditions of operation and other data for recommendations and quotations.
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SUPER SEAL
SCRAPER RINGS
meet or exceed* military specifications. For all hydraulic components, use fully approved Super-Seals . . . either AN-6231 standards, or AN-6231-A series. Definitely superior for all installations. Your inquiry promptly acknowledged.
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AN-6228 and AN-6229 "V" Ring Adapters
APPROVED
Gadgets, inc.
3829 N. DIXIE DRIVE, DAYTON, OHIO

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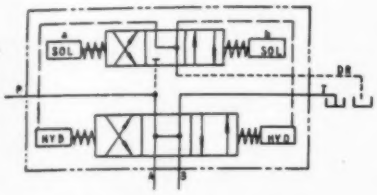
of oil pressure to do the heavy positioning work on the spool.

The other two J.I.C. symbols show two more of the many porting arrangements which can be had. One is still a 2 position, four-way valve but the springs in the first example



Three Position, Spring Centered, 4-way Valve

have been replaced by a double solenoid 2 position, four-way solenoid valve controlling a double piloted spool.

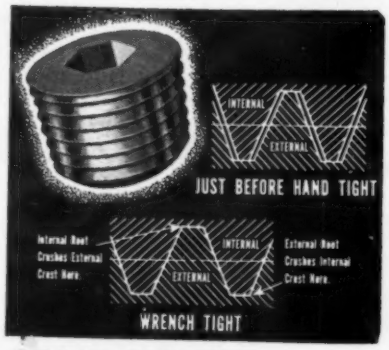
The last symbol shows a 3 position valve which is spring centered and its working positions pilot operated and solenoid controlled.

UNBRAKO®

DRYSEAL

THREAD

PRESSURE PLUG



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WITHOUT COMPOUND

Unique thread design of UNBRAKO "DRYSEAL" Pressure Plugs provides positive sealing at both major and minor diameters of threads, preventing spiral leakage, even under extreme pressures. Full range of sizes from 1/16" to 1¼" N.P.T.F.

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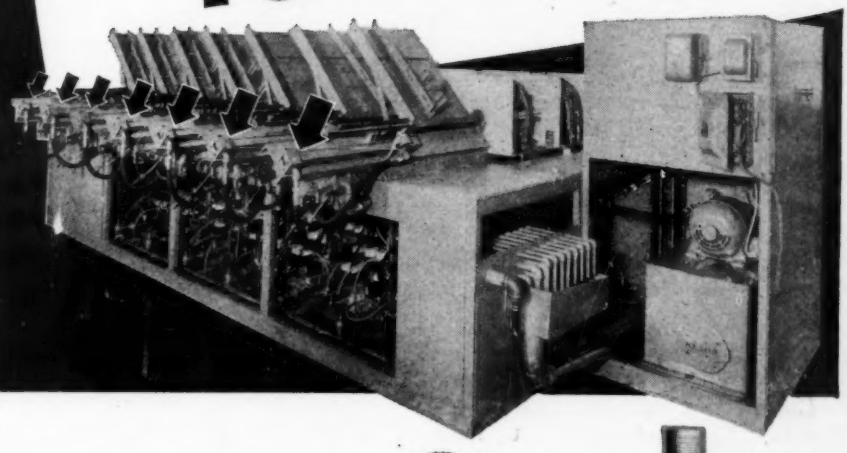
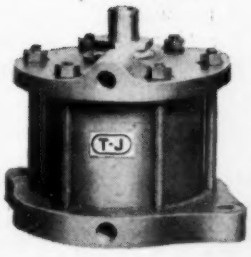
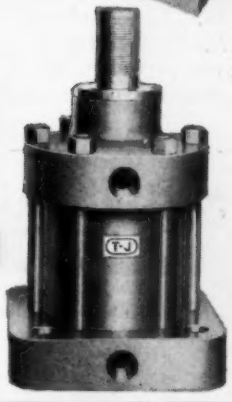




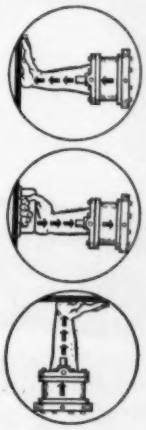


T-J Hydraulic Cylinders furnish efficient, automatic "push power" for feeding devices in this new Ajax-Northrup induction forge heating equipment.

This unit—manufactured by Ajax Electrothermic Corp., Trenton, N. J.—automatically heats steel forging stock in sizes ranging from 1 to 4 inches (rounds or squares) at 2250°F. at rate of 7500 to 8500 lbs. per hour. Has space for 8 heating stations . . . each with *hydraulically operated billet feeding devices employing T-J Cylinders.* These cylinders also eject heated bars automatically. Induction heating with this equipment results in uniformity of successive billets fed to the forge—thus controlling quality of finished forgings and reducing rejects.

Do you have a tough job in power movement—pushing, pulling or lifting? Let T-J help you *simplify machines, save labor* and *cut costs* by using T-J Air or Hydraulic Cylinders! Many standard sizes and styles . . . cushioned or non-cushioned . . . 100 lb. or 50,000 lb. Precision-built, long life. Write for more information. The Tomkins-Johnson Co., Jackson, Mich.

FOR POWER MOVEMENT IN ANY DIRECTION



100 LBS. or 50,000 LBS.

35 YEARS EXPERIENCE

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RIVITORS...AIR AND HYDRAULIC CYLINDERS...CUTTERS...CLINCHORS

T-J

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POST SCRIPTS OF INDUSTRY

NEWS · VIEWS · TRENDS

R. B. MacKenzie has been appointed assistant sales manager of **The Parker Appliance Co.** His primary assignment will be the coordination and handling of activities resulting from the government's increasing defense program requirements for Parker material produced by the company's Fitting, Valve, Jet Part and Rubber Divisions.

C. E. (Neil) Thomas has joined the sales staff of **Chiksan Company's** eastern headquarters, 155 Washington St., Newark, N. J. Previously, he was a sales representative for General Cable Corporation.

Kenneth Knotts has been advanced from sales manager to director of sales, according to an announcement made by J. E. Collins, president of **Valvair, Inc.**

The appointments of **James A. Moody** to material control manager and **William O. Hall** to chief project and test engineer are two important promotions at the **C. A. Norgren Co.** announced by C. Neil Norgren, assistant general manager. Mr. Moody will be responsible for keeping Norgren operations in conformance with government restrictions and regulations covering various materials.

The Cleco Division of the Reed Roller Bit Company, Houston, Texas, has announced the appointment of Harris Pump & Supply Company, Brady & Sidney Streets, S. S., Pittsburgh 3, Pa., as distributors for Cleco products in their area.

Paul F. Horbatt has joined the staff of **Nielson Hydraulic Equipment, Inc.** as sales engineer, assigned to the New Jersey Territory. Horbatt was formerly assistant editor of Product Engineering, where he specialized in editing hydraulic and design analysis articles for almost two years. Prior to this position, he was head of the Gear and Clutch Unit in the Research Division of the Wright Aeronautical Corp.

B. R. Teree and L. J. Henderson, chief engineer and sales manager, respectively, Aviation

NOW IMMEDIATE DELIVERY — GOODYER

PUR-LUB-AIRE UNITS

A mechanical and scientifically advanced principle for purifying, lubricating and regulating compressed air.

PUR-LUB-AIRE combines three units and functions.

1. PUR-O-FIER — Purifies air from source. Removes scale, moisture and excess oil from compressed air lines.
2. PUR-O-LUBER—Introduces finely vaporized oil into lines. Offers controlled mixture of air and finely atomized oil to desired ratio. Special design permits oil mist to impinge on any surface reached by the compressed air.
3. REGULATED AIR PRESSURE — of discharge air is accurately controlled with no creep on gauge and minimum fluctuation from initial pressures.

Discharge pipe sizes: 1/4"; 3/8"; 1/2"; 3/4"; 1"; 1 1/4"; 1 1/2"; 2"; 2 1/2"; 3" 1 cfm. to 1000 cfm. air volume. Available in combination or separately — Manual or Automatic.

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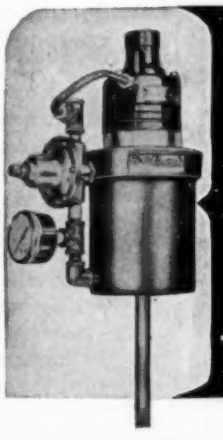

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NEW CONOFLOW PNEUMATIC CYLINDER MOTORS for **THROTTLING CONTROL**

The New B-50 Series of pneumatic cylinders for throttling control service operate on air pressures up to 100 psig and are capable of repositioning accuracies of 1/500 part of total stem travel. Simplified one-piece piston construction features graphite impregnated "O" ring seals and a piston positioner integrally mounted in the head plate. Extra sensitive, speedy and stable—because of minimum friction and precisioned aluminum design.

Many applications include positioning electrical components, variable speed drives, rubber pinch valves, etc. Available in 4", 6" and 8" diameters with 3" and 4" stem travels. Furnished complete with cushion-loading regulator and gauge, fully piped, ready for installation.

Write for bulletin B-50-AH.

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2100 Arch St., Phila. 3, Pa.

Cono Controls

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Division, **Weatherhead Co.** visited the 12th flying dispaly and exhibition of the Society of British Aircraft Constructors at Farnborough, England the week of September 11-16. Teree expressed the opinion that a number of the latest developments in equipment were showing the way for American designers and manufacturers. Both made a special study of the hydraulic and pneumatic components exhibited.

Lewis G. Kranick has joined **Milwaukee Metal Working Company** as vice president.

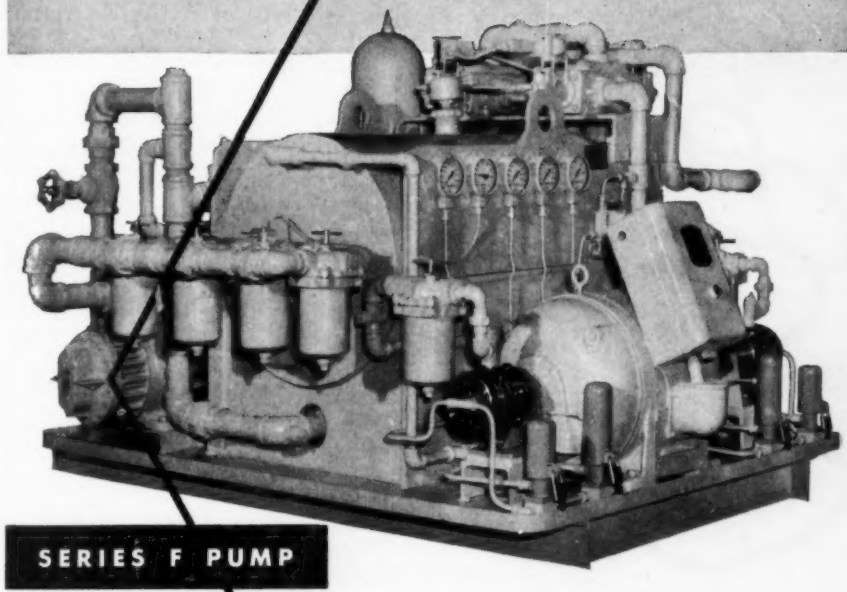
J. B. Waskey is now assistant to the vice president of production, Pacific Airmotive Corporation. In his new position, Waskey, who was formerly manager of Engine Division, Burbank, will utilize his background of over 20 years production experience.

Bernard Peyton, president, **The New York Air Brake Company,** announced the purchase of the stock of **Hydraulic Equipment Company,** Cleveland. The purchase is part of the program of diversifying the products of The New York Air Brake Co. Officers of Hydraulic Equipment Company will remain as in the past with the addition of two officers of The New York Air Brake Company, **Bernard Peyton,** president, and **Lewis K. Sillcox,** executive vice president, who became Chairman and Vice Chairman, respectively, of the Board of Directors of Hydraulic Equipment Company.

Worthington Pump and Machinery Corporation has named seven plant executives to new posts: **George P. Passmore,** assistant to the vice president in charge of manufacturing at Harrison, N. J.; **A. M. Tullo,** works manager of the company's Wellsville, N. Y. plant; **John Burdick,** assistant to the works manager at the Harrison plant in charge of industrial engineering activities; **Max A. Heyman,** assistant to the works manager at the Harrison plant in charge of production control activities.

Engineering executive appointments are: **W. D. Sizer,**

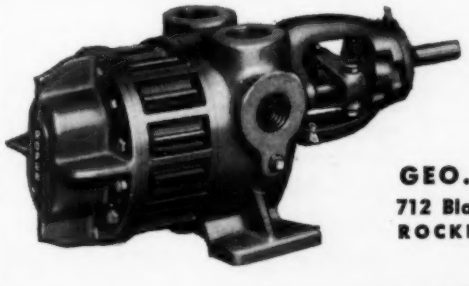
ANOTHER EXAMPLE OF **ROPER** DEPENDABILITY IN HYDRAULIC APPLICATIONS



ROPER PUMP QUICKLY CHARGES THE CIRCUIT IN THIS SECO UNIT

This Seco Fluid Power Package has all the essential components for automatic high-low hydraulic press operation. In this application, a fast-acting Roper Series "F" Pump is used as the low pressure generator; it supplies power to the circuit which closes the daylight opening of the press ram. Because the Roper Pump and a Seco pump operate intermittently, it is possible for the unit to operate two or more presses alternately.

Roper Series "F" Pumps feature 4-port design giving eight optional piping arrangements; are supplied in standard or stainless steel fitted models; come with or without relief valve, with mechanical seal or packed box. Pressures to 300 P.S.I. — Capacities 1 to 300 G.P.M. Perhaps you, too, have a hydraulic application which calls for the installation of a *dependable* Roper.



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ROPER Rotary Pumps

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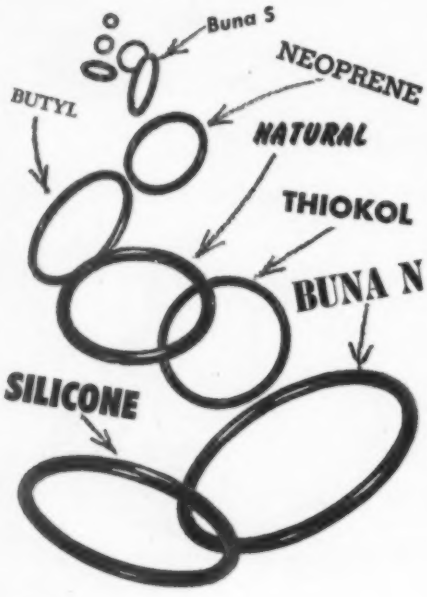
SPECIAL "O" RINGS



Many modern mechanisms present designers with new and difficult sealing problems created by unusual operating conditions. Frequently, special "O" rings are required, to insure a reliable seal in applications where extremes of temperature or very high pressures are encountered, or where the seal is exposed to fluids, gases, or chemicals which would damage a standard ring. Precision "O" rings moulded from Arrowhead special compounds have solved countless critical sealing problems. If you have a tough one, your inquiry is invited. It will receive the personal attention of our Director of Engineering Research.

GET THESE VALUABLE ENGINEERING AIDS

1. "O" RING MANUAL — *Contains illustrated design information and data on the selection, installation and proper use of "O" rings.*

2. DATA SHEETS — *Work sheets to assist designers in the selection of proper ring and most suitable compound, or in determining cause of "O" ring failure. Provides expert technical advice at no obligation.*

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ARROWHEAD RUBBER COMPANY
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A DIVISION OF NATIONAL MOTOR BEARING CO., INC.

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manager of regional engineering and service department, with headquarters at Harrison; **George F. Habach,** executive engineer at the Harrison plant; **Everett Schmachtenberg,** chief engineer of the centrifugal engineering division at the Harrison plant.

Edward O. Boshell, chairman and president of **Westinghouse Air Brake Company,** and Thomas Meloy, president of **Melpar, Inc.** announced that Westinghouse Air Brake Company has purchased all of the stock of Melpar, Inc., of Alexandria, Virginia, and Cambridge, Massachusetts. Melpar, Inc. is engaged in the research and development of electronics.

Col. Kern D. Metzger, USAF, has been named head of a new combined office at Wright-Patterson AF, Dayton, which will include Aircraft Production Resources Agency and the Industrial Resources division of Air Material Command. **Col. George Schaetzel,** who has been Air Force member of APRA has been transferred to the staff of Maj. Gen. Mark Bradley, Jr., AMC, Director of Procurement and Industrial Planning.

Appointment of **Wenzel A. Linfors** as sales manager of the **New York Belting and Packing Co.** has been announced by B. F. Ruether, vice president.

M. T. Kinnison has been appointed assistant purchasing agent of **Jas. P. Marsh Corporation,** Skokie, Illinois, manufacturers of gauges, thermometers, regulating valves, solenoid valves and heating specialties. Mr. Kinnison has been serving under Philip Keppeler, purchasing agent, for the past ten years.

President R. B. Werey, **Conoflow Corporation,** has announced the opening of an auxiliary plant to enlarge its manufacturing facilities in the Philadelphia area. Manufacturers of pneumatic control equipment, Conoflow has expanded it activities. A two story building, near the main office and factory, has been leased.

PLENTY of POWER

IN THESE HYDRAULIC PUMPS and FLUID MOTORS

There's plenty of power in Eastern fluid motors and hydraulic pumps. They're tough and compact—ideal where space is at a premium. They're dependable, too. Long life under rugged operating conditions is built-in. An Eastern hydraulic pump or fluid motor in your design is good engineering.

SERIES 100

.1 to 5 GPM—Drive speeds up to 3450 RPM. Working pressures up to 1000 PSI. Average volumetric efficiency: 90%. Average model weight: 1.65 lbs.

Lightweight construction is obtained through use of aluminum housings and nitralloy gears and shafts. Each unit is factory pre-tested for precision and operating efficiency.

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Ledeen cylinders provide positive, dependable power and pressure in straight line motion. Designed for air, oil, or water operation, they are uniform in design and construction, affording a wide number of varieties and adaptations. Ledeen cylinders are easy to install, occupy minimum space, and are built for long, economical service.

Standard Ledeen cylinders and mountings are available from distributors' stocks in major cities. Special cylinders if required. J.I.C., of course.

Ledeen Cylinders are GOOD Cylinders

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Ledeen Mfg. Co.
1610 So. San Pedro St.
Los Angeles 15, Cal.

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William Rowley has been appointed manager of **Aeroquip Corporation's** new office located in the Monument Building, Dayton, Ohio. Rowley has been a staff engineer for Aeroquip since he joined the company in 1948. He was previously associated with the Ranger Aircraft Corporation, Glenn L. Martin and Pitcairn Autogyro Corporation.

Malvern J. Hiller has been appointed president of **The Commonwealth Engineering Company of Ohio.** He has served for the last three years as executive vice president. Mr. Hiller has been successively a research chemist with Sharples Solvents Co., district sales manager of the Sharples Chemical, Inc., and later director of research and development, Stepan Chemical Co., Chicago, Ill.

E. B. Wiggins Oil Tool Co., Inc., Los Angeles announces the appointment of **Jack Minor** as sales manager. The company manufactures quick disconnect couplings.

ASA Letter Symbols for Hydraulics Committee Asks for Assistance

THE American Standards Association Subcommittee Y1-0.2 (formerly Z10.2), Letter Symbols for Hydraulics, has recently been reconstituted for the purpose of reviewing and revising the 1942 Standards, which are generally considered obsolescent.

The committee would appreciate receiving comments from interested designers and engineers regarding any changes or modifications to the 1942 Standards. It has been tentatively decided to consider the field of hydraulics as being concerned with all phases of the motion of liquids. An attempt will be made to include symbols in the field of hydrology and water-hammer. Suggestions and comments should be directed to the Chairman, Dr. J. M. Robertson, P. O. Box 30, State College, Pa.

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✓Check the KOBE HIGH PRESSURE TRIPLEX PUMP

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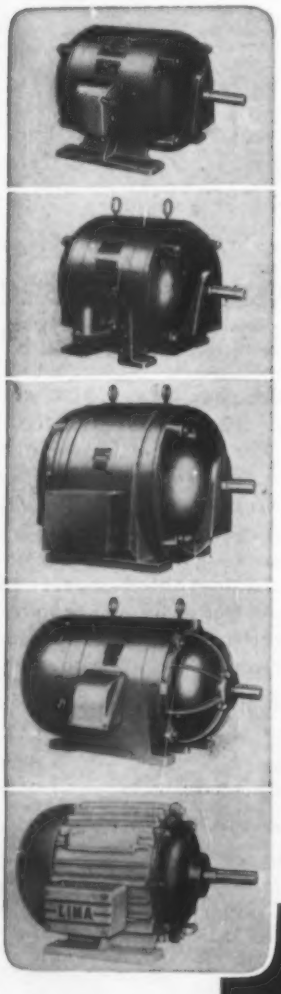

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Original equipment manufacturers, quick to observe the performance of these motors, are specifying LIMA for their products.

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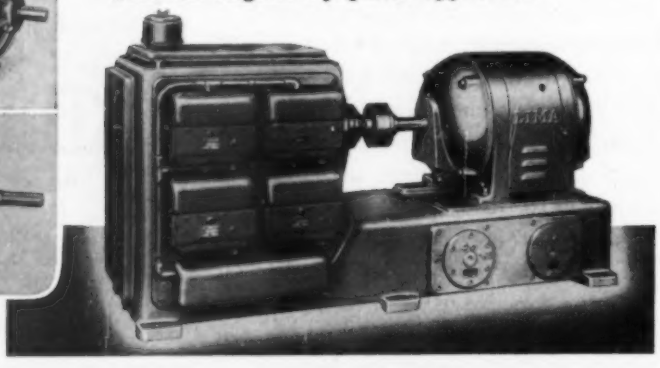
Photo below shows a LIMA Dripproof Motor, direct-coupled to a BARNES L Type Hydraulic Unit—an original equipment application.



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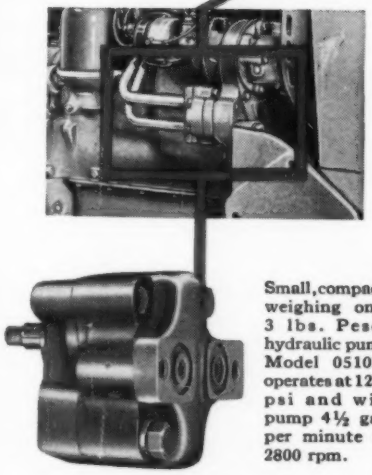
PESCO HYDRAULIC POWER

ON FARMALL SUPER C TOO!



Small, compact, weighing only 3 lbs. Pesco hydraulic pump Model 051012 operates at 1200 psi and will pump 4½ gal. per minute at 2800 rpm.

For rugged, dependable duty in the fields, the powerful Farmall Super C tractor is equipped with a Pesco hydraulic pump. This pump powers the hydraulic system that gives complete finger-tip control of the tillage tools . . . control that makes farm work easier . . . lessens time spent in the fields. International Harvester uses smooth Pesco hydraulic power to do the heavy work on Farmall Cub, Super A and Super C. This is because Pesco hydraulic engineers have developed hydraulic pumps that give top-flight performance with little or no maintenance.

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Announcing...

2nd ANNUAL EQUIPMENT DIRECTORY ISSUE

We are again preparing to give you up to date information on components for hydraulic and pneumatic systems in the January, 1952 issue. Last year's First Annual Directory number received the enthusiastic approval of thousands of readers.

This January Equipment Directory issue will be of particular importance now. With present high production schedules and expanding facilities and equipment, it is more important than ever to be able to quickly find what components are commercially available and who makes them.

The January, 1952 Annual Equipment Directory is being developed to give production, design, and maintenance men a central reference that will include:

1) A complete product listing

2) A manufacturers' listing

3) Trends and plans for what's ahead in '52

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